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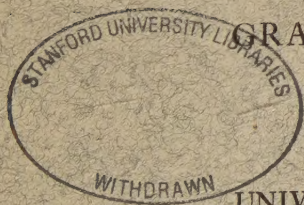
THE NITROGEN DISTRIBUTION IN BEEF FLESH AS AFFECTED BY AGE AND CONDITION

by

WALTER S. RITCHIE. B. S. A., A. M.

Submitted in Partial Fulfilment of the Requirements
for the Degree of Doctor of Philosophy

in the



GRADUATE SCHOOL

of the

UNIVERSITY OF MISSOURI
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Studies in Animal Nutrition

IV. The Nitrogen, Ash and Phosphorus Distribution in Beef Flesh As Affected by Age and Condition

WALTER S. RITCHIE, C. ROBERT MOULTON[†], P. F. TROWBRIDGE[‡],
L. D. HAIGH

This bulletin forms one of the general series of Studies in Animal Nutrition issued from this Agricultural Experiment Station. Besides those animals comprising what was known as the "Use of Feed" group there are included also the "Special Maintenance" and "General Maintenance" groups and a few cows. General details of these experiments can be found in Research Bulletins 28, 30, 43, 51, 54, and 55 of this Station. General acknowledgments are included in the bulletins. The present bulletin deals with the forms of protein in beef flesh as separated by a cold water extract and subsequent coagulations and precipitations.

REVIEW OF LITERATURE

In 1912 Cathcart* started an investigation which had for its objects the determination of the capacity of the liver to absorb ammonia after its introduction into the blood stream and the effect of different diets on the ammonia content of the tissues. After the first four experiments the research began to widen out, muscle tissue was analyzed as well as the liver and in addition to the ammonia, total soluble or non-protein nitrogen, amino acid and amide nitrogen were determined with the view to learning the initial nitrogen distribution in the tissues and the effect produced by intravenous injection. The ammonia determination was soon given up due to the large number of analyses to be run.

"As the initial variations in the nitrogen content of the tissues were found to be very wide, the attempt to determine the influence of the diet on it was abandoned after the fifteenth experiment; the variations up to this time had no definite relation to the diet and

*This bulletin contains the dissertation of Walter S. Ritchie presented to the Graduate School of the University of Missouri in partial fulfillment of the conditions for the degree of Doctor of Philosophy, April, 1922. To this have been added some data on the ash and phosphorus distribution in beef flesh.

[†]Resigned, January, 1923. [‡]Resigned, September, 1918.

*All superscript numerals in the text refer to the bibliography.

were therefore judged to be physiological." Cathcart adds that this statement means that in their particular set of experiments the variation could not be attributed to the diet.

Intravenous injections of physiological salt solutions were made in dogs to determine the effect on the nitrogen content and its distribution and on the water content of the tissues. Later the effect of injecting glycocoll and urea was also investigated.

The nitrogen of the tissues is mainly in the form of coagulable or protein nitrogen but a small percentage can be washed out of the tissue which is neither coagulable by heat nor affected by the ordinary protein precipitants. The main constituents of this soluble or non-protein nitrogen are the amino acid, amide and ammonia nitrogen and they constitute about 60 per cent of the soluble nitrogen.

TABLE I.—NITROGEN IN MUSCLE. BOLD-FACE FIGURES REPRESENT MG. NITROGEN IN 100 G. MOIST TISSUE. LIGHT-FACE FIGURES REPRESENT G. NITROGEN IN 1,000 G. DRIED TISSUE.

Total Soluble N.		Amino Acid N.		Amide N.		Ammonia N.	
Before	After	Before	After	Before	After	Before	After
379	383	78.7	79.3	38.6	46.3	10.8	12.3
15.2	15.4	3.16	3.20	1.55	1.87	0.440	0.495

TABLE II.—AVERAGE FIGURE FOR THE WHOLE SERIES OF EXPERIMENTS OF BOTH THE TOTAL SOLUBLE OR NON-PROTEIN NITROGEN AND OF THE PROTEIN NITROGEN AS A PERCENTAGE OF THE TOTAL NITROGEN. BOLD-FACE FIGURES REPRESENT THE NON-PROTEIN NITROGEN; THE LIGHT-FACE FIGURES REPRESENT THE PROTEIN NITROGEN.

Liver		Muscle	
Before	After	Before	After
9.5	10.3	11.1	11.2
90.5	89.7	88.9	88.8

The Tables I and II show Cathcart's results on nitrogen in the dried tissue and the total soluble nitrogen or non-protein nitrogen as a per cent of the total nitrogen.

Cathcart, as a result of the experiments, concludes that, "Variation is the rule in those aspects of tissue analysis which form the

subject of her communication, there is not a single instance of a constant value or a relation although the range of variation is much greater in some relations than in others.

"The intravenous injection of ammonia, urea, and glycocoll respectively, produces an accumulation of these bodies as such in the liver and to some extent in the muscle. There is no evidence of the synthesis of any of these substances into protein but there is abundant proof of their further metabolism particularly in the liver; ammonia is converted into amide nitrogen in both liver and muscle, urea is de-aminized in the liver and muscle while glycocoll is de-aminized in the liver and is partially converted into amide nitrogen in both the liver and the muscle."

In answer to the question what changes do the different forms of nitrogen in the muscle tissue undergo during hunger Buglia and Constantino² conducted an investigation with dogs as subjects.

These dogs after hungering for varying lengths of time were killed by bleeding. Certain muscles were taken and an extract with 20 per cent alcohol made, upon which determinations of total nitrogen, extractive nitrogen and amino acid nitrogen were made.

TABLE III.—THE NITROGEN DISTRIBUTION IN DRIED AND FRESH MUSCLE.

Experiments	Value in per cent of the muscle dried at 105-110°.			Value in per cent of the fresh muscle.		
	Total N. (gms.)	Extrac- tive N. (gms.)	Formol titrated amino acid.	Total N. (gms.)	Extrac- tive N. (gms.)	Formol titrated amino acid.
Average of six dogs	14.262	1.71	0.40	3.272	0.286	0.92
Av. of two animals (<i>Octopus vulgaris</i>)	13.455	3.865	0.896	2.995	0.89	0.186

The dog shows no great variation in the amount of total nitrogen but there is a slight increase in both the total extractive nitrogen and the amino acid nitrogen as the period of starvation progresses.*

The above experiment was supplemented with two experiments each of which had for the subject an octopus. These animals were killed immediately after capture. The shell muscle was dissected out and treated just as was the muscle from the dog.

*Since these differences are so slight, only the average of the six dogs is presented. The figures for the octopus are an average of two animals.

The results are opposite from those of the dog. The total nitrogen decreases as well as does the extractive nitrogen and the amino acid nitrogen as the period of starvation goes on.

Buglia and Constantino conclude their article by saying that the results obtained with the octopus do not justify any conclusions regarding the changes in the composition of muscle during hunger.

Joseph³ made a study of the forms of nitrogen in growing pigs with special reference to the influence of the quantity of protein consumed. This investigation was divided into two sections, the first dealing with the influence of the quantity of protein consumed upon the forms of nitrogen in the body, and the second with the average distribution of the forms of nitrogen in the bodies of pigs 40 to 43 weeks old.

Joseph remarks in his review of literature that, thus far, the data presented by other investigators indicate that the character and quantity of the feed consumed exert no influence on the protein content of the animal body or any of its parts excepting the influence that depends on the rate of growth or fattening.

The experiment was conducted on twelve carefully selected Berkshire pigs weighing on the average 51 pounds. These were divided into three groups of four pigs each in such a way that the groups were practically alike as regards ancestry, age, weight, and condition. Lot I received a low protein diet, Lot II a medium protein diet and Lot III a high protein diet. The diets consisted of ground corn, blood meal, and calcium phosphate. The amounts of ground corn and blood meal were varied to furnish the diets of low, medium and high protein content.

Analyses were made on the pigs at the end of the investigation. Only one pig survived in Lot I and two were slaughtered from Lots II and III.

Table IV gives results (average results for Lots II and III) of the analysis of the boneless dressed carcass on the fresh basis. The forms of nitrogen in the bodies of the pigs 40 to 43 weeks old appear in the Table V.

Joseph concludes from the data obtained in the investigation that variations of from 0.32 to 0.94 pounds per 100 pounds live weight per day in the amounts of protein consumed per day do not seem to affect the nature of the nitrogenous material produced during growth. While variations may result from differences in

TABLE IV.—FORMS OF NITROGEN IN BONELESS MEAT OF DRESSED CARCASS.
(Results Expressed in Per Cent of Fresh Substance)

Animals	Protein Nitrogen.			Non-protein Nitrogen.									
	Total Nitro- gen.	Soluble Nitro- gen.	Soluble		Insolu- ble.	Extractive		Total					
			Coagu- lable.	Precipi- tated by acids ¹ .		Creatin	Other than creatin.		Ammo- nia.				
Lot I. Low Protein													
	2.169	0.523	0.243	0.118	0.361	1.646	2.007	0.087	0.038	0.125	0.037	0.162	
Lot II. Medium Protein.													
Average of two ani- mals		1.961	0.496	0.246	0.082	0.328	1.465	1.793	0.079	0.060	0.140	0.028	0.168
Lot III. High Protein.													
Average of two ani- mals		2.000	0.425	0.211	0.074	0.285	1.575	1.860	0.080	0.038	0.199	0.021	0.140
Average of Five Animals.													
2.018	0.473	0.231	0.086	0.317	1.545	1.863	0.081	0.047	0.129	0.027	0.156		

¹Tannic and phosphotungstic acids.

the amount of protein consumed, it seems more probable that the variations are due to causes inherent in the animal itself which are independent of the character of the food.

As to the nitrogen distribution it appears that, when the supply of protein is deficient either quantitatively or qualitatively, only the amount of the body protein is affected while the character of the proteins in the various tissues remains unchanged.

Clark and Almy⁴ used 20 common food fishes in their work on the influence of season on composition of the flesh. They present a bibliography of work along this line but the analyses were confined mainly to the determinations of solids, fat, ash, and nitrogen.

The fish used were obtained on the market but the history was known of each sample and all were fresh according to commercial standards. Determinations of the total solids, nitrogen, fat, and ash were run as well as the cold water soluble nitrogen, coagulable nitrogen, hot water soluble nitrogen, and the ammonia nitrogen.

Table VI presents some few of the results obtained by Clark and Almy.

The hot water extraction of the edible tissue was made because of the likelihood of the relatively large and possibly significant quantities of gelatin-like substances in the tissues. The results indicate that this is more or less constant in the same species of fish but may vary with the species. With the nitrogenous material soluble in cold water it is seen that this fraction as well as the coagulable nitrogen in the cold water extract follow the same trend, i. e., a relative constancy with the same fish at different times but a wide variation between fish of different species at the same time.

The quantity of nitrogen by aeration is usually accepted as indicating the progress of post mortem changes in the composition of flesh, especially those of decay as opposed to ripening changes. The quantities of ammoniacal nitrogen obtained from fresh fish of different species becomes important. The material used in this study was fresh as thought of in the market sense of that term. Had the same time elapsed with all samples between removal from water and the examinations, more uniform results would probably have been found. Such variations do occur between the ammoniacal nitrogen of fat-poor and fat-rich tissue and can not be disregarded. Clark and Almy remark in conclusion "that the report deals only with the composition of the edible flesh of the fish and a similar study should be made of the viscera before an attempt is made to attach any undue biological significance to the results".

TABLE VI.—PERCENTAGE COMPOSITION OF THE EDIBLE PART OF FISH.
Fresh Basis.

No. of Sample.	Common name of fish.	When caught	Solids	Fat	Ash	Nitrogen			
						Total	Cold water soluble.	Coagu- lable.	Hot water soluble.
6	Flounder	Apr. 19	17.54	0.20	1.17	2.56	0.888	0.477	0.117
25	Flounder	Sept. 22	21.59	0.37	1.34	2.54	0.740	0.330	0.200
2	Haddock	Apr. 2	18.32	0.15	1.11	2.33	0.748	0.343	0.147
22	Haddock	Aug. 21	20.83	0.09	1.01	2.59	0.800	0.520	0.150
5	Striped Bass	Apr. 16	25.70	3.58	1.26	3.21	1.153	0.719	0.102
29	Striped Bass	Oct. 16	19.83	2.98	1.26	3.07	1.050	0.650	0.0166
10	Sea Bass	May 12	22.02	1.61	1.23	2.98	0.967	0.532	0.106
24	Sea Bass	Sept. 14	19.44	1.60	1.09		0.970	0.700	0.0220

The nitrogen distribution in a hot water extract of the non-protein fractions has been worked out by Von Furth and Schwartz⁵. The lean fat-free muscles of the horse and dog and the heart of the horse were used for these studies.

The samples were freed of fat and connective tissue, finely ground and cooked in hot water and filtered. The filtrate was used for the determinations. These men summarize their results in Table VII. In the original article there is a table summarizing their work and that of some other investigators. These men conclude that the results do not justify any conclusions as to the difference in the non-protein nitrogen fraction. The creatin and carnosine occupy the prominent positions in these data, and in these new results appears a problem for muscle physiology.

TABLE VII.—NITROGEN DISTRIBUTION—FLESH OF HORSE AND DOG.

Form	Horse Flesh I		Horse Flesh II		Dog Muscle normal	
	Grams N. In 100 g. muscle	% of total N.	Grams N. In 100 g. muscle	% of total N.	Grams N. In 100 g. muscle	% of total N.
Ammonia	0.0172	4.50	0.0229	6.99	(0.0179)	(5.31)
Purin bodies	0.0233	6.10	0.0364	11.12	0.0274	8.31
Creatin +						
Creatinin	0.1013	26.50	0.1216	37.17	0.1075	31.90
Carnosin	0.1159	30.30	0.1052	32.15	0.1086	32.23
Basic residual						
fractions	0.0584	15.28	0.0270	8.27	0.0494	14.66
Amino acid	0.0223	5.83	0.0077	2.35		
Polypeptide	0.0091	2.38	0.0025	0.76		
					0.0262	7.77
Urea	0.0302	7.90	0.0039	1.19		
Residual	0.0045	1.21	-----			
	0.3822	100.00	0.3272	100.00	0.3370	100.00

While the work of Clark and Almy showed no great variations in the composition of the edible flesh of fresh fish, the work of C. H. Greene⁶ showed considerable variation in the lean muscle of fish. Greene's material for his investigation was confined to one species, the king salmon. These fish were taken at five different points along the hundreds of miles traveled by them up the Columbia

River from the sea to the spawning beds. These fish were collected by C. W. Greene⁷ and used in another connection, that of an investigation on the Biochemical Changes in Muscle Tissue of King Salmon during the Fast of the Spawning Migration.

The investigation of C. H. Greene was confined to the study of the nitrogenous extractive distribution of the salmon muscle, the extractive nitrogen, the amino nitrogen and the total creatin nitrogen.

Table VIII is a composite table taken from C. H. Greene's article. Greene concludes that the total extractives in the fat-free tissue increase during the greater part of the migration. The nitrogen in the organic extractives remains approximately constant.

The non-protein amino nitrogen increases in per cent in the fat-free muscle during this migration.

The concentration of amino nitrogen relative to the water in the muscles increases from 82 to 100 mg. per 100 grams of water, coincidently with the augmentation of catabolism at the beginning of the migration. The amino nitrogen shows no further change during the migration.

The total creatin nitrogen is not essentially changed during the migration but relative to the protein in the muscle it increases sharply.

In 1904, Grindley⁸ began an investigation which had for its object the study of the chemistry of the nitrogenous constituents of the flesh of meats. Researches up to this time had been confined almost entirely to proteins of blood or to proteins of muscle free from blood. The object of the investigations was then the study of the nitrogenous constituents of flesh as it is used for food.

Data on the solubilities of the various nitrogenous constituents were lacking, so it was necessary for his work to take up rather carefully this phase of the question. Extracts were accordingly made with the following reagents: cold water, 10 per cent sodium chloride solution, 0.15 per cent hydrochloric acid solution, 0.15 per cent potassium hydroxide solution and lastly with hot water.

Two samples of lean beef were taken from two-year-old animals and also one sample of cooked meat. All bone and gristle as well as fat was removed so that only lean flesh was used. From the data it is apparent that Grindley found a considerable portion of the raw beef soluble in cold water.

TABLE VIII.—CHANGES IN COMPOSITION OF MUSCLE OF SALMON DURING MIGRATION*.

Station	Location	Pro- res- due.	ter Wa- ex- tract.	Extrac- tive nitro- gen.	Pro- tein res- due.	Amino nitro- gen.	Pro- tein res- due.	Total creatin- e nitro- gen.	Pro- tein res- due.
		%	%	%	%	%	%	%	%
Ilwaco	Tide-water	20.3	4.79	0.482	2.37	0.061	0.300	0.081	0.400
Warrendale	130 miles	19.9	4.65	0.524	2.63	0.076	0.380	0.094	0.470
Seufert	210 miles	19.7	4.70	0.521	2.67	0.078	0.400	0.078	0.400
Ontario	700 miles	18.3	4.75	0.553	3.04	0.074	0.410	0.089	0.510
Cazadero	Spawning grounds	13.8	4.34	0.534	3.82	0.084	0.590	0.089	0.610

*Averages in percentages as calculated on the fat-free basis.

Of the nitrogen of the cold water extracts expressed in terms of the total nitrogen in the meat, 19.66 to 24.64 per cent is soluble in cold water, the average of beef being 21.71 per cent and that of veal 22.39 per cent. The nitrogen in the form of proteid in the cold water extracts forms from 9.38 to 10.03 per cent of the total nitrogen of the fresh material.

The non-protein nitrogen in the water soluble portion forms from 9.48 to 11.79 per cent of the total nitrogen in the raw flesh, and 0.22 to 0.62 per cent of the nitrogen of the fresh meat is in the water soluble form as ammonium salts.

The data are also shown in per cent of the total water soluble nitrogen or nitrogen distribution. From 39.30 to 48.48 per cent of the soluble nitrogen of the beef is coagulable by heat, the average being 44.55 per cent, while in the veal the average was 43.41 per cent. From 2.63 to 8 per cent of the soluble nitrogen was precipitated in the solution from the determination of the coagulable nitrogen by use of zinc sulphate. This is supposed to be albumoses. Bromine added to the solution left after filtering off the zinc sulphate precipitate is supposed to remove peptones and these amount to 0.46 to 2.60 per cent of the soluble nitrogen.

From this work Grindley draws the conclusion that a considerable portion of raw flesh is soluble in cold water. Such a solution has in it 12.14 per cent of the total proteid of raw meat. In fact, 22 per cent of the nitrogen of raw meat is soluble in cold water. The nitrogen in these cold water extracts is about equally divided between protein and non-protein substances.

The ordinary methods of analysis do not include the direct determination of the constituents of flesh which are of importance in that they impart to meat much of its flavor and are a stimulus to digestion. The principles are the nitrogenous and non-nitrogenous extractives.

Realizing the limitations of the ordinary methods of analyses which bring about fundamental changes in the proteid substances, Grindley and Emmett⁹ thought it desirable to attempt the analysis of the fresh material and to prepare the water extract of the raw flesh so that a more complete differentiation could be made of these principles.

The method that they developed and used for the preparation of the cold water extract is described later.

Their conclusions were that considerable part of the dry portion of either raw or cooked flesh is soluble in cold water and that

the proteids of the flesh differ in character and properties. Though a large part of the protein material of meat is insoluble in cold water, still not a small part of it is soluble. Of the soluble proteids of raw meat the greater portion is coagulable by heat. In addition to the heat coagulable proteids in the extract, there are albumoses precipitated with zinc sulphate and peptones which are brought down with tannin and sodium chloride.

The data presented by Grindley and Emmett indicate clearly that meats contain a considerable quantity of the so-called organic extracts and that these extractives are non-nitrogenous as well as nitrogenous. In lean fresh beef the nitrogenous organic extractives vary from 1.00 to 1.75 per cent while the non-nitrogenous organic extractives vary from 1.40 to 2.20 per cent. Cooking the lean meat changes the amounts of these extractives.

Emmett and Grindley's¹⁰ next effort was along the line of phosphorus content of raw and cooked meat. They studied the total phosphorus, soluble and insoluble phosphorus, its distribution in the meat, and the relation of the various forms of phosphorus to the total and soluble ash. Some of their conclusions may be summarized as follows:

1. Of the total phosphorus in beef 75 per cent is soluble in water.
2. Of the total phosphorus in beef 25 per cent is in the form of soluble organic phosphorus.
3. Of the soluble phosphorus about one-third is in the form of soluble organic phosphorus.
4. Phosphorus is 23.4 per cent of the ash of beef.
5. Soluble phosphorus is 17 to 18 per cent of the ash of beef.
6. In veal, fat has no influence on the amount of phosphorus present.

In studying the acidity of the flesh Trowbridge and Grindley¹¹ confined their work to four studies: (1) The acidity of flesh; (2) Proteids of flesh soluble in cold water; (3) Proteids of the flesh insoluble in cold water but soluble in a 10 per cent solution of ammonium sulphate; and (4) Proteids of flesh insoluble in a N/20 potassium hydroxide solution in the cold.

While some nitrogen separation is made in the work, the results are not comparable to any to be presented later, so the reader is referred to the original article for data on this research of Trowbridge and Grindley.

Grindley and his co-workers in his studies used normal beef tissue. It was thought that beef tissue from an investigation where age and planes of nutrition varied, would make an interesting study. Consequently, the work, which is described later was done in connection with the Use of Food investigation of the University of Missouri Agricultural Experiment Station.

Some of the data which appear have been published before in another connection by C. R. Moulton¹². As some of his tables will be used his work is not reviewed here.

EXPERIMENTAL

The data included in this bulletin were obtained from the analyses of certain samples of flesh, part of which were taken during the course of an investigation conducted for the purpose of determining the "use to which a beef animal puts its food". Other samples were obtained from animals in projects not a part of the Use of Food experiment but run parallel to it and in connection with it.

THE USE OF FEED GROUP

The animals in the Use of Feed investigation were all Hereford-Shorthorn grade steers. These were bought as calves and kept until 4 to 6 months old at which ages they were divided into the experimental groups. However the animals killed before the age of 11 months were put on group rations when a few weeks old. Before weaning they received as food whole milk and some hay and grain. The continuous ration for the animals was: six parts corn chop, three parts whole oats, one part linseed meal; one-half as much alfalfa hay as grain.

Planes of Nutrition.—Group I animals were fed all they would eat of the ration. They were not considered full-fed unless some of the food was refused at least twice in ten days.

Group II animals were fed to secure maximum growth without the storage of fat. This condition was determined by the opinion of the men in the animal husbandry department. For the younger animals (under two years) a gain of about 1 pound a day seemed to give this condition. These animals refused practically no feed.

Group III animals were to have their growth distinctly retarded. They were to be in a condition in which one would expect to find cattle that were not properly cared for. An average gain of $\frac{1}{2}$ pound a day was judged to keep animals in about the desired

condition. Animals under 18 months required to gain a little more than this or they became extremely thin. Animals over 3 years old began to improve in condition if allowed to gain continuously the one-half pound per day.

The progress of the experiment showed that considerable mortality must be expected with the Group III animals. They always suffered more severely from indigestion, pink eye, or any other ailment to which the animals were subject.

Table IX gives the number, age and group of the Use of Food animals considered in this report.

Records were kept of the feed consumed, and the weights of the animals were taken daily. From time to time, when deemed advisable, animals were taken from the various groups, slaughtered and analyzed. For further details see Missouri Agricultural Experiment Station Research Bulletin 43.

TABLE IX.—THE USE OF FOOD ANIMALS.

No. of Animal	Group	Age at slaughter	No. of Animal	Group	Age at slaughter
500	III	48 mo.	527	I	40 mo.
501	I	48 mo.	531	III	17-18 mo.
502	II	45 mo.	532	I	17-18 mo.
503	II	11 mo.	538	II	11 mo.
504	I	21-26 mo.	540	III	11 mo.
505	I	11 mo.	541	I	11 mo.
507	II	34-35 mo.	547	I	8½ mo.
509	III	45 mo.	548	III	5½ mo.
512	II	48 mo.	550	II	8½ mo.
513	I	45 mo.	552	II	5½ mo.
515	I	34-35 mo.	554	II	3 mo.
523	II	21-26 mo.	555	III	3 mo.
524	III	40 mo.	556	I	3 mo.
525	III	21-26 mo.	557	I	5½ mo.
526	II	40 mo.	558	III	8½ mo.

THE SPECIAL MAINTENANCE GROUP

Besides those animals regularly of the Use of Feed experiment, there were other animals from which data were derived. Animals 594, 591, 597, 593, 592, 595, and 599 were of the same general type as those of the Use of Feed group and were fed as special maintenance animals. These animals were fed until about 11 months old on the same plane of nutrition up to a fat condition. When they

were all in such a condition, No. 594 was selected as a check animal and slaughtered. The remainder were divided into the three groups of the experiment.

Planes of Nutrition.—**Supermaintenance.**—This group was fed to permit a gain of $\frac{1}{2}$ pound in weight per day. Steers 593 and 599, the fattest and most thrifty of the animals were put in this group.

Maintenance.—The steers in this group, 597 and 595 were fed so that there was no change in the weight of the animal. These two animals were selected for this group since they were the next two in thrift and fatness as compared to 593 and 599.

Submaintenance.—A loss of $\frac{1}{2}$ pound of weight per day was the standard for this group which included steers 591 and 592. These were the thinnest and poorest animals of the six, but fatter than Steer 594, the check animal.

Up to a month before the slaughter of 594, the check animal, these animals were receiving a ration of grain: corn chops eight parts and linseed meal one part, with as much alfalfa hay as they cared for. Then the ration was regulated so that the ratio of hay to grain, was one part of hay to two and one-half parts of grain. This ratio was varied from time to time when necessary to control the gain or loss of each group.

After an interval of six months, one animal from each group was slaughtered, those selected being 593 of the Supermaintenance group, 597 of the Maintenance group, and 591 of the Submaintenance group. Six months later Steers 592 and 595 were slaughtered. No. 599 was marketed since it was thought that data from his carcass would be of little value.

During the first six months the animals showed a decided tendency to grow in spite of the severe treatment. The ration had to be reduced to bring about the desired effect. In the latter part, the tendency was the reverse and the animals lost in weight. Steer 592 was in very bad condition at the time of slaughter as he was very thin, staggering as he walked and with a more or less glassy appearance in the eyes.

The following Table X gives the group, approximate age at the time of slaughter, and number of these Special Maintenance animals.

For further details see Missouri Agricultural Experiment Station Research Bulletin 28.

TABLE X.—THE SPECIAL MAINTENANCE ANIMALS.

No. of Animal	Group	Age at slaughter
594	Check animal	11 months
593	Supermaintenance	17 months
599	Supermaintenance	sold
597	Maintenance	17 months
595	Maintenance	23 months
592	Submaintenance	21 months
591	Submaintenance	17 months

THE REGULAR MAINTENANCE GROUP

Steers 18, 121, 48 and 197 were animals from which other samples were obtained. Animals 18, 121 and 48 were grade Shorthorns which had been in a feeding experiment of the department of animal husbandry. They were discarded from this experiment as poor feeders and put on maintenance trials.

These steers were fed a grain ration of corn chop eight parts, and linseed meal one part, and alfalfa hay; the hay being four-tenths as much as the grain. These animals were put on the maintenance trials the same day.

Steer 18. At the beginning of the maintenance trial, this steer weighed 764.6 pounds (age 21 months). In the interval between the feeding trial and the maintenance trial he had lost about 100 pounds. At the end of the maintenance trial of 9½ months he weighed 778.1 pounds and was much thinner than at the beginning. At the age of about 30 months he was slaughtered.

Steer 197 was fed as a show steer getting as food all it would eat of a mixture of equal parts of ground oats and bran. In addition it was fed corn and oil meal. This food was increased gradually from ¼ pound up to 2 pounds. At the age of 14 months, Steer 197 was put on maintenance. The animal lost in weight and condition and could not be kept at a constant weight until two months later when it weighed 1088.2 pounds. It gradually lost weight and weighed 1079.9 pounds at the end of the experiment. It was then slaughtered at about the age of 39 months after having been in maintenance for two years.

Steer 121. This steer weighed 763.5 pounds at the beginning of the trial, having lost 80 pounds in the interval between the feeding trial and the maintenance trial. At the end of the maintenance trial its weight was 764.2 pounds and it was very thin.

Steer 48. After losing 80 pounds between the feeding experiment and the maintenance trial, Steer 48 weighed 840 pounds. At the end of the trial, it weighed 841.5 pounds and was very thin.

After this maintenance trial Steer 121 was fattened to a half-fat condition and slaughtered at the age of 32 months. Steer 48 was fattened to a very fat overdone condition and was slaughtered at the age of 57 months.

Feed and weight records were kept and certain measurements were taken during the experiment. For further details see Missouri Agricultural Experiment Station Research Bulletin 30.

OTHER GROUPS

From three registered aged Jersey cows No. 63, 4 and 43, samples were also obtained which contribute to the data of this paper. These were dry and had been on maintenance for several months. They were in medium condition of flesh and in fairly uniform condition.

No. 63 was slaughtered as a check animal at the age of about six years.

Cow No. 4 was continued on maintenance and brought to the condition of No. 63 at which time she weighed 875 pounds. The animal was then fattened on a dairy ration of grain: corn chop four parts, bran two parts, and linseed meal one part, alfalfa hay and silage. These were in the ratio of 6 pounds of grain, 6 pounds of hay, and 24 pounds of silage at the beginning of the period. The fattening period lasted 130 days at the end of which time the cow weighed 1026.4 pounds.

The Cow No. 43 was fattened after the maintenance period on a beef ration: corn chop eight parts, linseed meal one part, and alfalfa hay, four-tenths as much hay as grain. The cow during a fattening period of 160 days increased in weight from 758 pounds to 1057.8 pounds.

At the end of the fattening period of No. 43, both 43 and 4 were slaughtered. At that time Cow 43 was 7 years old and Cow 4 was 9 years old. Feed and weight records were kept of these cows during the maintenance and fattening periods.

Samples were also taken from a grade Hereford steer by the name of "Jerry". The animal was in prime condition having been fitted up for the show ring. It was 3 years old.

Animal 562c was a new born calf of the Hereford-Shorthorn type and the data are included for comparison.

SAMPLES

As the animals finished the experimental periods described above, they were slaughtered. Various samples and composite samples were taken. These were analyzed on the fresh basis for water, protein, fat, ash, and phosphorus. In addition to these determinations cold water extracts were made of certain samples and it is with these extracts that we are now primarily concerned. In Tables XI and XII are the data regarding the samples analyzed.

TABLE XI.—LIST OF SAMPLES ; "USE OF FOOD" ANIMALS.

Samples	3 months			5½ months			8½ months			11 months		
	I	II	III	I	II	III	I	II	III	I	II	III
Lean and fat composite	556	554	555	557	552	548	547	550	558	541	538	540

TABLE XI.—CONTINUED.

Samples	17-18 months			40 months			45 months		
	I	II	III	I	II	III	I	II	III
Lean and fat composite	532	---	531	527	525	524	513	502	509

TABLE XI.—CONTINUED.

Samples	11 months			21-26 months			34-35 months			48 months		
	I	II	III	I	II	III	I	II	III	I	II	III
Loin lean----	505	503	---	504	523	525	515	507	---	501	512	500
Loin fat-----	505	503	---	504	523	525	515	507	---	---	---	---
Round lean---	505	503	---	504	523	525	515	507	---	501	512	500
Round fat----	505	503	---	504	523	525	515	507	---	---	---	---
Rib lean ----	505	503	---	504	523	525	515	507	---	501	512	500
Rib fat-----	505	503	---	504	523	525	515	507	---	---	---	---

METHODS OF ANALYSIS

The methods of analysis were those of the Association of Official Agricultural Chemists. Moisture was determined by means of the vacuum desiccator and sulphuric acid. Fat was determined

TABLE XII.—LIST OF SAMPLES; MISCELLANEOUS ANIMALS.

Samples	Supermaintenance		Maintenance		Submaintenance	
	Animal	Age	Animal	Age	Animal	Age
Fat composite-----	593	17 mos.	597	17 mos.	591	17 mos.
	599		595	23 mos.	592	21 mos.
Lean composite-----	593	17 mos.	597	17 mos.	591	17 mos.
			595	23 mos.	592	21 mos.
Flesh composite-----	594*					

*Control animal

TABLE XII.—CONTINUED.

Samples	Dairy Cows		Regular Maintenance	
	Animal	Age	Animal	Age
Lean composite-----	63	6 yrs.	197	27 mos.
	4	9 yrs.	---	-----
	43	7 yrs.	---	-----
Round lean--	---	-----	18	30 mos.
	---	-----	121	32 mos.
	---	-----	48	57 mos.
Rib lean-----	---	-----	18	30 mos.
	---	-----	121	32 mos.
	---	-----	48	57 mos.
Loin lean----	---	-----	18	30 mos.
	---	-----	121	32 mos.
	---	-----	48	57 mos.

NOTE.—Lean and fat samples of the rib of a show steer "Jerry," as well as a flesh composite of a newborn calf are also used.

indirectly by ether extraction, nitrogen by the Kjeldahl-Gunning-Arnold method, ash by ignition in porcelain crucibles, and phosphorus on the ashed sample by the gravimetric method. Phosphorus was determined in the water extract after digestion of the evaporated solution with sulphuric acid.

The cold water extracts were analyzed for total solids, ash, total nitrogen and phosphorus. The cold water extract, as well as the determination of the nitrogen distribution in it, was made, following the methods of Grindley and Emmett⁹, the general details of which follow.

THE PREPARATION OF THE COLD WATER EXTRACT

Of the sample to be extracted, whether lean, fat, or lean and fat composite, four portions of 45 grams each were taken. These were weighed by difference from glass stoppered weighing bottles. Each of the 45-gram portions was divided between five small beakers. To each beaker was added 50 cc. of distilled carbon-dioxide-free water in four or five portions. Between the additions of these small amounts of water, the sample was thoroughly mixed and rubbed up with a stirring rod to insure thorough extraction. After allowing the insoluble residue to settle, the clear liquid was poured on filters and allowed to drain into 300-cc. flasks. The residue was thoroughly drained and was then again treated with water, this time with 25 cc. The water and residue were stirred and then allowed to settle and extract for five or ten minutes. After settling, the clear solution was again decanted through the same filter. This treatment was continued, using 25 cc. of extracting water each time, until the filtrate was about 250-cc. in volume. The filters were allowed to drain completely after each extraction. After the last extraction the entire contents of each beaker were transferred to the filter and when drained were washed twice with water. The filtrates were then made up to six or eight liters, rinsing each flask twice with water.

To test for complete extraction Grindley and his co-workers made a second extraction. They found that, though the extraction was not quite complete, the differences were well within the limits of experimental error.

THE ANALYSIS OF THE COLD WATER EXTRACT

Determination of Total Soluble Solids and Ash.—Portions of 100 cc. of the extract were evaporated to dryness in weighed platinum dishes. These were dried to constant weight in the water oven. The dried residues were carefully ignited over a free flame at a low red heat until colorless. The dishes were then quickly weighed, heated and weighed again, this being repeated until a constant weight was obtained.

Determination of Total Nitrogen.—Portions of 100 cc. of the extract were used to determine the nitrogen in the usual manner.

Determination of the Heat-Coagulable Nitrogen.—After many trials the following method was adopted for this determination. Portions of 100 cc. each were evaporated on the water bath. As it is necessary to maintain a neutral solution at this point, the extract was evaporated to about 25 cc. in the presence of freshly precipi-

tated magnesium carbonate. When a volume of 25 cc. was obtained, the coagulum was filtered off and washed with hot water. The residue on the filter was then run for nitrogen by the usual Kjeldahl-Gunning-Arnold method.

The Determination of Proteose.—The filtrates and washings from the determination of the heat coagulable nitrogen after slight acidification with acetic acid were evaporated on the water bath to a volume of 30 cc. and allowed to cool. One cc. of 50 per cent sulphuric acid was added and the solution completely saturated with zinc sulphate. The solution was then heated on the water bath with stirring until clear, allowed to stand for 12 hours, and then filtered. The precipitate was thoroughly washed with a saturated solution of zinc sulphate, slightly acidified with sulphuric acid. The nitrogen in the residue was determined by the Kjeldahl-Gunning-Arnold method.

Determination of Peptones and Peptids.—Salt and tannic acid precipitate all protein material leaving amino acids and extractives. From the total water soluble nitrogen subtract the sum of the coagulable nitrogen, the nitrogen precipitated by zinc sulphate and the amino acids and extractives. The difference will be peptones and peptids.

Determination of Amino Acids and Extractives.—Portions of 100 cc. each of the original water extract were used for this determination after all the heat-coagulable nitrogen had been removed. The filtrates and washings from such 100-cc. portions were treated after concentration in 100 cc. graduated flasks with 15 grams of sodium chloride and 30 cc. of a 24 per cent tannic acid solution. The flasks were filled to the mark, shaken vigorously and allowed to stand over night at a temperature of 15° C. These solutions were filtered and 50-cc. samples of the filtrate were taken for the nitrogen determinations which were made in the usual manner.

The Determination of Phosphorus in the Water Extract.—The methods of Grindley have been used so far but his method for organic phosphorus in cold water extracts, as shown by Francis and Trowbridge¹³, does not give high enough results as the heat coagulation has changed nearly all the organic phosphorus to the inorganic form. The following methods were used for the phosphorus determinations in this work.

Total Soluble Phosphorus.—Portions of 500 cc. of the extract were measured into 600-cc. beakers and evaporated on the water bath to a volume of about 50 cc; with the aid of 15 cc. of sulphuric acid and hot water this was transferred to 500-cc. Kjeldahl flasks.

Then about 0.7 gram mercury together with 5 grams of potassium sulphate were added and the solution digested as for nitrogen determinations.

After cooling, the liquid and any residue was washed into a 250-cc. beaker, slightly diluted with water and neutralized with ammonia. The operation was then completed as under total phosphorus.

Soluble Organic Phosphorus.—Portions of 600 cc. of the extract were measured into 1000-cc. Erlenmeyer flasks and 5 cc. of 10 per cent barium chloride solution, 10 cc. of ammonia (diluted, 1:1) and 45 cc. of water were added making a total of 660 cc. representing 12 grams of the original sample. This was thoroughly mixed, covered with a watch glass and allowed to stand over night or until the precipitate had settled. It was then filtered through a dry filter, 605 cc. (eleven-twelfths) of the filtrate were placed in a dry 1000-cc. Erlenmeyer flask and 10 cc. of 5 per cent potassium sulphate solution and 45 cc. of water were added, making a total volume of 660 cc. The solution was thoroughly mixed and allowed to stand long enough for the precipitate to settle, then filtered or decanted, according to the condition of the precipitate. Five-sixths of the original sample (600 cc.) were measured into 800-cc. beakers and treated in the same manner as under total soluble phosphorus above.

Soluble Inorganic Phosphorus.—The difference between the organic and the total soluble phosphorus was considered to be inorganic phosphorus.

THE METHOD OF COMPUTING DATA

The results of the analyses of these samples are shown in Tables 1 to 9 in the Appendix. These figures are the results on the wet and fat-containing basis. According to C. W. Greene⁷ and C. R. Moulton¹², this method of presentation of data is not desirable as the results are influenced by the diluting effect of the fat. Tables 10 to 18 of the Appendix show the same results as Tables 1 to 9 but calculated on the fat-free or protoplasmic basis.

PART I.—NITROGEN

All data presented in the body of this bulletin are given on the fat-free or protoplasmic basis. The discussion is based on these figures. This should be understood, as this explanation will not be repeated again in the bulletin. The data which are presented in the following discussion, are taken from Tables 10 to 18.

THE COMPARISON OF THE COMPOSITION OF LEAN MUSCLE AND FATTY TISSUE

Special Maintenance Animals.—*Total Nitrogen.*—Table XIII shows nitrogen distribution in the lean composite and fat composite samples of the Special Maintenance animals whose plane of nutrition and treatment have already been described. Animal 592 is included in the table of lean composites, although it is a lean and fat composite with a fat content of 1.87 per cent. It is omitted from the fat composites since it is practically a lean sample.

TABLE XIII.—NITROGEN DISTRIBUTION. LEAN MUSCLE AND FATTY TISSUE.
Special Maintenance Animals

Animal	Age	Condition	Total nitrogen	In % of Total Nitrogen			In % of Soluble Nitrogen	
				Soluble Nitrogen	Coagu- lable nitro- gen	Amino acid & extra- ctive ni- trogen	Coagu- lable nitro- gen	Amino acid & extra- ctive ni- trogen
Lean Composite								
592	21 mo.	Very thin	3.210	14.704	4.829	6.499	32.841	43.859
591	17 mo.	Very thin	3.329	19.495	8.741	6.939	44.837	35.594
595	23 mo.	Thin	3.335	17.631	8.036	6.867	45.597	38.948
597	17 mo.	Fairly fat	3.299	19.612	7.608	7.123	38.794	36.320
593	17 mo.	Fat	3.234	17.996	7.050	6.867	39.175	38.158
594	11 mo.	Fat	3.523	18.876	8.629	6.756	45.714	35.791
Fat Composite								
591	21 mo.	Very thin	3.553	6.867	2.927	3.377	42.624	49.177
595	23 mo.	Thin	4.044	7.690	3.264	1.335	42.445	17.360
597	17 mo.	Fairly fat	3.962	8.682	4.013	2.726	45.222	31.398
593	17 mo.	Fat	4.134	8.539	3.048	2.879	35.695	33.716
594	11 mo.	Fat	4.579	6.397	2.664	1.201	41.781	18.774

From the data in Table XIII, it is clear that the variations in the total nitrogen between the different individuals for both the fat and lean composites are not significant. The tables indicate a tendency in both composites for the nitrogen to increase as the planes of nutrition improve. The total nitrogen of the fat composites is distinctly higher than that of the lean composites. This might be expected as the lean tissue is a much more watery tissue than tissue which forms the framework of the fat.

Soluble Nitrogen.—The significant figures in this Table XIII are those of the soluble nitrogen and its distribution. The soluble nitrogen in the lean composites is greater than in the fat muscle by at least 100 per cent. Since the lean muscle is a more active tissue than the fatty tissue such a difference might be expected.

In every case, the values for the coagulable nitrogen and the amino acid and extractive nitrogen, in per cent of the total nitrogen, are higher in the lean composites than in the fat composites. The coagulable nitrogen is at least 100 per cent higher and the amino acid and extractive nitrogen is 250 per cent higher.

The coagulable nitrogen in per cent of the water soluble nitrogen seems to be higher in the lean composite than in the fat composite though the total of the two would probably be very nearly the same.

The ratio of the amino acid and extractive nitrogen to the soluble nitrogen is clearly higher in the lean composite than in the fat composite. As the amino acids appear in the muscle tissue both as the results of the breaking down of tissue and as a means of the synthesis of proteins, it is to be expected that in an active tissue as the muscle tissue the relative amounts of the amino acid and extractive nitrogen would be higher than in an inert tissue such as the fatty tissue.

From Table XIII there appears a difference not only in the quantity but also in the quality of the proteins of these two different kinds of tissue. The lean composite has a smaller relative amount of total nitrogen in it but of this amount of total nitrogen, it has a greater amount of soluble nitrogen. In relation to the total soluble nitrogen, the coagulable nitrogen of the two series of composites is about the same, but the amino acid and extractive nitrogen of the lean composites is much higher than in the fat composites. If an even more active tissue, such as the liver, was to be compared with the muscle tissue, it is likely that the smaller nitrogen fractions would appear in even greater relative quantities than in the muscle tissue.

There is no general appearance in these tables of the effect of either age or nutrition on the nitrogen distribution in either the lean or fat composites. In animal 592, there is a marked decrease in the soluble and coagulable nitrogen in the lean composite. This animal was very badly underfed and shows in its lean composite a decrease of nearly 20 per cent in the soluble nitrogen and about 35 per cent in the coagulable nitrogen.

Lean and Fat Flesh of Rib.—*Total Nitrogen.*—Table XIV shows the total nitrogen in the lean and fat flesh of the rib from

the Use of Food animals. As the table indicates there are five ages of animals from birth to 48 months and three groups, which are described elsewhere in this paper.

TABLE XIV.—TOTAL NITROGEN—RIB FLESH.
(Use of Food Animals)

Group	Lean of Rib			Fat of Rib		
	I	II	III	I	II	III
At Birth	2.724	2.724	2.724			
11 mo.	3.668	3.513		4.041	4.480	
21-26 mo.	3.565	3.439	3.461	4.300	4.315	4.196
34-35 mo.	3.487	3.417		3.365	4.210	
48 mo.	3.556	3.489	3.645			

In the case of these lean and fat samples, as in the case of the preceding composites, the amount of total nitrogen of the fat samples is greater than that of the lean samples. The total nitrogen of the lean samples does not vary a great deal with age though there is a considerable rise from the total nitrogen of the calf at birth which is used for comparison. In the fat sample, the total nitrogen decreases with age.

The effects which might be due to the plane of nutrition do not appear to be marked in the total nitrogen of these two tissues. With the lean sample, the tendency is toward a less nitrogen content but these changes are too small to be significant.

TABLE XV.—SOLUBLE NITROGEN IN PER CENT OF TOTAL NITROGEN—FLESH OF RIB.
(Use of Food Animals)

Group	Lean of Rib			Fat of Rib		
	I	II	III	I	II	III
At birth	18.979	18.979	18.979	-----	-----	-----
11 mo.	19.057	17.990	-----	9.498	9.598	-----
21-26 mo.	18.850	17.912	18.318	6.953	11.124	9.509
34-35	19.444	20.515	-----	5.682	5.920	-----
48 mo.	18.954	19.433	21.509	-----	-----	-----

Soluble Nitrogen.—The values for the soluble nitrogen in per cent of the total nitrogen, Table XV, are at least 100 per cent greater in the lean samples than in the fat samples for all three

groups. In Group I the total soluble nitrogen of the lean samples is fairly constant while with the fat samples the tendency is toward a lower content as the age increases. In Group II, the lean sample show a distinct increase in the total soluble nitrogen content and the fat sample as the age increases. With Group III there is somewhat of a rise in the water soluble nitrogen of the lean flesh. Since there is but one fat sample in Group III, no comparisons can be made.

Considering the water soluble heat-coagulable nitrogen of the lean rib, Table XVI, there appears a decided rise from birth to 48 months. This rise holds fairly well in all three groups.

TABLE XVI.—COAGULABLE NITROGEN IN PER CENT OF TOTAL NITROGEN—FLESH OF RIB.

(Use of Food Animals)

Group	Lean of Rib			Fat of Rib		
	I	II	III	I	II	III
At birth.....	6.828	6.828	6.828	-----	-----	-----
11 mo.....	8.097	8.739	-----	3.567	2.433	-----
21-26 mo.....	7.686	7.415	7.743	2.651	5.238	2.359
34-35 mo.....	9.578	9.892	-----	2.288	2.438	-----
48 mo.....	9.421	10.003	11.276	-----	-----	-----

The water soluble heat-coagulable nitrogen of the lean increases as the condition of the animal becomes poorer. The fat samples, however, in general show the opposite effect. In Group I, the relative amount of coagulable nitrogen decreases with age but in Group II there is apparently no change. Group III having but one sample in it makes a comparison impossible. No conclusion is justified as to the effect of the plane of nutrition on the coagulable nitrogen of the fat samples.

The amino acid and extractive nitrogen, shown in Table XVII, in per cent of total nitrogen, in all but one case of the lean samples, decreases as the animal matures. The flesh of a young animal is usually considered more tender than that of an old animal. As an

animal matures and grows thinner, a decrease in this fraction might be expected and such appears to be the case with these animals.

TABLE XVII.—AMINO ACID AND EXTRACTIVE NITROGEN IN PER CENT OF TOTAL NITROGEN—FLESH OF RIB.
(Use of Food Animals)

Group	Lean of Rib			Fat of Rib		
	I	II	III	I	II	III
At birth.....	10.095	10.095	10.095	-----	-----	-----
11 mo.....	9.051	7.173	-----	3.431	1.696	-----
21-26 mo.....	7.742	7.473	6.674	2.884	2.387	1.549
34-35 mo.....	6.940	6.204	-----	1.961	2.438	-----
48 mo.-----	6.271	6.649	7.737	-----	-----	-----

The 4-year-old animals show the reverse, however. The amino acid and extractive nitrogen of the fat samples decrease with increasing age in Group I but show the opposite effect in Group II. In all but one case it decreases with the lower plane of nutrition.

In the foregoing discussion based on Tables XIV to XVII while variation seems to be the rule, there are one or two very definite points. Again, as with the lean and fat compositions discussed earlier, there is a difference between the lean and the fat samples not only in the quantity of nitrogen but in the quality of nitrogen as well. There is a greater relative amount of total nitrogen in the fat flesh, on a fat-free basis, than in the lean flesh. Of this smaller amount of total nitrogen in the lean flesh a larger part is soluble in the lean flesh than in the fat flesh. The amounts of the coagulable nitrogen and the amino acid and extractive nitrogen in per cent of the total nitrogen are also greater in the lean flesh than in the fat flesh.

Considering the coagulable nitrogen and the amino acid and extractive nitrogen in per cent of the soluble nitrogen, it appears from Table XVIII that there is more or less individual variation.

In five out of seven cases where comparison is possible the lean shows a greater proportion of soluble nitrogen in the form of coagulable nitrogen than does the fat. The differences however are not great. In seven out of ten cases there is an increase with decreasing plane of nutrition and about the same relative number

TABLE XVIII.—COAGULABLE AND AMINO ACID NITROGEN IN PER CENT OF SOLUBLE NITROGEN—FLESH OF RIB.
(Use of Food Animals)

Group	Lean of Rib			Fat of Rib		
	I	II	III	I	II	III
Coagulable Nitrogen						
At birth.....	35.977	35.977	35.977	-----	-----	-----
11 mo.....	42.489	48.576	-----	37.560	25.349	-----
21-26 mo.....	40.774	41.396	42.271	38.127	47.082	48.170
34-35 mo.....	49.263	48.217	-----	45.029	41.176	-----
48 mo.....	49.703	51.475	52.424	-----	-----	-----
Amino Acid and Extractive Nitrogen						
At birth.....	53.191	53.191	53.191	-----	-----	-----
11 mo.....	49.626	39.873	-----	36.124	17.674	-----
21-16 mo.....	41.071	41.721	36.435	41.472	21.458	16.291
34-35 mo.....	35.693	30.243	-----	38.596	41.176	-----
48 mo.....	33.086	34.218	35.969	-----	-----	-----

show increases with increasing age. At birth 36 per cent of the soluble nitrogen is coagulable while at maturity 50 to 52.5 per cent is coagulable.

The amino acid and extractive nitrogen shows in general the opposite state. In four cases this fraction is a greater part of the soluble nitrogen in the lean than in the fat samples. In three cases the reverse is true. With decreasing planes of nutrition there is a smaller part appearing as amino acid and extractive nitrogen in both lean and fat samples. The lean of the 4-year-old cattle, however, shows the reverse. In general, this fraction decreases with age being 53 per cent of the soluble in the lean of the calf at birth and but 33 per cent in the rib lean of the 4-year-old Group I steer.

Lean and Fat Flesh of Rib of Fat Steer.—With Jerry, the 3-year-old show steer, the difference between the fat and lean samples of the rib is very marked. There is a smaller relative amount of total nitrogen in the lean than in the fat flesh. Of this total nitrogen nearly nine times as much is water soluble in the lean flesh as in the fat flesh. Over four times as much of this total nitrogen is

TABLE XIX.—NITROGEN DISTRIBUTION IN LEAN AND FAT FLESH OF RIB.—SHOW STEER JERRY.

Sample	Total nitrogen	In % of Total Nitrogen			In % of Soluble Nitrogen	
		Soluble nitrogen	Coagu- lable nitrogen	Amino acid & extractive nitrogen	Coagu- lable nitrogen	Amino acid & extractive nitrogen
Lean of rib	3,366	19,816	7,635	7,160	28,531	36,132
Fat of rib	3,853	2,725	1,895	1,479	69,524	54,286

in the heat coagulable fraction and about five times as much in the amino acid and extractive nitrogen. The soluble nitrogen of the rib lean shows about the same proportion of amino acid and extractive nitrogen as is shown for an animal of the same age in Group I in Table XVII. The coagulable nitrogen of the rib lean is lower by about 10 per cent. The figures for the rib fat should be considered with caution. The sample of rib fat as taken for the water extract contained about 97 per cent of water and fat. An aliquot of the water extract then, contained in the form of coagulable or amino acid nitrogen only about as much nitrogen as a blank on the reagents. This renders all calculations to the fat free basis useless and makes it unwise to draw any conclusions from the data so obtained.

In general the comparison of the above lean and fat samples shows that the total nitrogen content and distribution is quite different for the two sorts of material and that the soluble nitrogen fraction is somewhat differently constituted in the two different tissues.

THE COMPARISON OF THE COMPOSITION OF THE MIXED LEAN AND FAT COMPOSITES

The Nitrogen Distribution.—Table XX gives the nitrogen distribution in the mixed lean and fat composition of a part of the Use of Feed animals (see Table 14 of the Appendix for these animals). A study of the total nitrogen shows a general tendency for the total nitrogen to be directly affected by age and condition. The values in all three groups rise as the animal matures and decrease as the plane of nutrition is lowered. In the balance of the table variation seems to be the rule and this might be expected. These animals have been fed to varying degrees of fatness and this fat has been mixed in with the lean flesh. The varying proportions

TABLE XX.—NITROGEN DISTRIBUTION—LEAN AND FAT COMPOSITES.—USE OF FOOD ANIMALS.

Age	Total Nitrogen			Soluble Nitrogen			Coagulable Nitrogen			Amino Acid & Extrac- tive Nitrogen		
	I	II	III	I	II	III	I	II	III	I	II	III
At birth.....	2.724	2.724	2.724	18.979	18.979	18.979	6.828	6.828	6.828	10.095	10.095	10.095
6 3 mo.....	3.333	3.231	3.150	21.842	20.118	19.048	9.751	7.768	6.095	7.471	7.088	8.444
5½ mo.....	3.344	3.237	3.238	17.852	21.440	17.480	8.642	11.306	7.597	8.463	8.156	7.875
8 ¼ mo.....	3.348	3.194	3.203	15.830	18.190	15.579	6.302	7.451	6.463	6.930	7.013	7.056
11 mo.....	3.686	3.379	3.304	17.607	17.704	18.614	7.379	7.103	8.777	7.434	8.316	7.446
17-18 mo.....	3.747	-----	3.686	19.162	-----	20.429	3.843	-----	8.383	8.567	-----	7.759
40 mo.....	3.389	3.595	3.509	17.793	17.274	18.267	7.377	7.844	7.951	6.374	6.676	6.897

of lean and fat in the different samples will be reflected in varying results. An increase in the fatty tissue would lessen the proportion of soluble nitrogen and its fractions.

A study of Table XX will show that the values for the soluble fractions of the total nitrogen in the Group I and II animals at 40 months are smaller than they should be. This is true of the total nitrogen values as well as for the soluble nitrogen values. It would appear that these lessened values are directly due to the diluting effect of the large amounts of fat found in the older and fatter animals. If this is the case, then the practice of mixing the lean flesh and the fat flesh into one composite is certainly to be condemned. That such a dilution is the case may be judged from the following data.

The Diluting Effect of the Fat Tissue.—Animal 527, the Group I animal at 40 months of age had in his make-up 135,989 grams of lean flesh and 125,332 grams of fat flesh. Using the composition of Jerry's samples as a basis for calculation the results shown in Table XXI are obtained.

TABLE XXI.—THE DILUTING EFFECT OF THE FATTY TISSUE.

	Wt. of flesh	% Total nitrogen	Wt. of total nitrogen	% Soluble nitrogen	Wt. of soluble nitrogen
Lean-----	135,989	2,583	3512.5	20.07	704.9
Fat-----	125,332	,477	597.8	7.946	47.5
			4110.3		752.4

The per cents of soluble nitrogen used are average values taken from the lean and fat flesh of the round, rib, and loin of the animals whose numbers appear in Table 3 of the Appendix. From the total soluble nitrogen and the total nitrogen, the total soluble nitrogen to total nitrogen ratio was determined.

The total nitrogen of the lean flesh is 3512.5 grams and the fat flesh 597.8 grams, a total nitrogen content of 4110.3 grams. If this were all lean flesh then the soluble nitrogen would amount to 824.9 grams. However, it contains 3512.5 grams of nitrogen in the lean flesh with a soluble content of 704.9 grams. The fat flesh has 597.8 grams of total nitrogen and a soluble nitrogen content of 47.5 grams. The sum of 704.9 grams and 47.5 grams, or 752.4 grams is the actual amount of soluble nitrogen in the 4110.3 grams of flesh composite.

If this 4110.3 grams were all lean flesh then its soluble nitrogen content would be 824.9 grams. The ratio between 752.4 grams and 824.9 grams is therefore the factor of dilution of the fat in this particular case. This amounts to practically 10 : 11.

If the value of 17.793 per cent for the total nitrogen in the Group I aged animal, from Table XX is increased according to this ratio, the value becomes 19.501 per cent. This increase would entirely alter the figures in Table XX for those animals having an appreciable amount of fatty tissue in the composite flesh sample. It therefore seems that the low figures for the aged animals of Groups I and II are a result of the diluting effect of the larger amount of fat.

THE METHOD OF HANDLING THE DATA OF THE 590 ANIMALS—ITS JUSTIFICATION

As has just been brought out, the practice of mixing lean and fat material is to be condemned as unwise and leading to false results. Table XXXI contains the data of the animals conveniently known as the 590 animals. They are the Special Maintenance group. While the discussion of these animals comes later, it is deemed advisable to insert here a few remarks concerning the method of handling their data. The table contains the data of the lean and fat flesh of this group of animals calculated as a composite flesh. In view of the above remarks about this practice this seems to need justification. In the treatment of these animals it will be recalled that they were fattened and then carried along on a diet which in some cases (591 and 592 at least) caused a considerable loss of weight. Steer 592, it will be remembered, was in such poor shape that he could hardly get around. Nevertheless he had some fatty tissue residues in him, for the animals fight hard to hold their fat and the severest kind of treatment is necessary to remove all the fat. This fatty tissue was then in with the lean flesh and was not hand separable so that the only sample of flesh from 592 was actually a lean and fat composite though the fat content (ether extract) was only 1.87 per cent, fresh basis. In order that the other animals could be compared it was necessary to calculate the lean and fat flesh to a composite sample. The animals could then be compared on an equal basis. It is quite true that this will lower the values for the animals having appreciable amounts of fatty tissue. If, in spite of this, the starved animal with a low fatty tissue content shows still lower results, this must be due to starvation and not to a change in the proportion of fatty tissue or

fatty tissue residues. Had the sample of 592 been compared with the lean composites of the other animals the results would have been even more striking than those shown.

THE EFFECT OF AGE AND NUTRITION ON THE COMPOSITION OF THE LEAN FLESH

Tables XXII, XXIII, XXIV, XXV, XXVI, and XXVII contain the data from strictly lean samples and permit a study of the effect of age and nutrition on the nitrogen distribution. These lean samples are taken from the rib, round, and loin of certain Use of Feed animals.

Total Nitrogen.—Table XXII contains the total nitrogen data for these three lean samples. The data show that there is practically no difference in the nitrogen content of the three different samples and that between the ages of eleven months and four years there is apparently no change due to age. The calf at birth has but three-fourths as much total nitrogen as do the other ani-

TABLE XXII.—TOTAL NITROGEN OF FAT-FREE MUSCLES.

Sample	Rib	Round	Loin	Rib	Round	Loin	Rib	Round	Loin
Group	I	I	I	II	II	II	III	III	III
Birth.....	2.724	2.724	2.724	2.724	2.724	2.724	2.724	2.724	2.724
11 mo.....	3.668	3.674	3.595	3.513	3.540	3.481	---	---	---
21-26 mo.....	3.565	3.533	3.476	3.439	3.230	3.379	3.461	3.197	3.353
34-35 mo.....	3.487	3.487	3.536	3.417	3.428	3.404	---	---	---
48 mo.....	3.556	3.409	3.488	3.489	3.392	3.588	3.645	3.236	3.375

mals. The sample for this animal is the composite of the entire flesh, there being no fat flesh that could be separated from the lean flesh. The samples for the Group I steers show a slightly greater nitrogen content than do the Group II or the Group III steers.

The changes occurring between birth and eleven months of age are shown in Table XXIII which presents data for composite lean and fat samples. There is but little fattening during this time. It appears that at three months two-thirds of the increase shown

TABLE XXIII.—TOTAL NITROGEN LEAN AND FAT COMPOSITES.

Group	I	II	III
Birth.....	2,724	2,724	2,724
3 mo.	3,333	3,231	3,150
5½ mo.....	3,344	3,237	3,238
8½ mo.....	3,348	3,194	3,203
11 mo.....	3,686	3,379	3,304

above has occurred. The remainder of the increase appears between the ninth and twelfth months. The change may be more gradual in pure lean samples but data is lacking on this point. The nitrogen content of Group I animals is higher in all cases.

From Table XXIII and the one immediately preceding there seems to be three divisions in the total nitrogen up to 48 months. The animal has a low value at birth. Beginning at three months, there is a rise to an amount which is fairly constant up to nine months. The value from 9 to 12 months up to 48 months is still higher and remains somewhat constant during this time.

Soluble Nitrogen.—Table XXIV shows the data of the total soluble nitrogen in per cent of the total nitrogen of the lean of the rib, round, and loin of the same ten animals.

TABLE XXIV.—SOLUBLE NITROGEN OF FAT-FREE MUSCLE.

In per cent of total nitrogen

Sample	Rib	Round	Loin	Rib	Round	Loin	Rib	Round	Loin
Group	I	I	I	II	II	II	III	III	III
At birth.....	18.979	18.979	18.979	18.979	18.979	18.979	18.979	18.979	18.979
11 mo.....	19.057	21.339	22.223	17.990	20.734	20.167			
21-26 mo.....	18.850	22.644	19.448	17.912	21.734	21.782	18.318	21.927	20.101
34-35 mo.....	19.444	19.702	19.061	20.515	20.799	21.886			
48mo.....	18.954	21.267	19.323	19.433	20.902	21.220	21.509	20.581	20.457

The effect of age upon the total soluble nitrogen is not very noticeable. The calf composite at birth had 18.979 per cent of the total nitrogen in the soluble form. At the age of 48 months all but one of the animals had increased a little above that figure. So during the life of the animal, there is a slight tendency for this fraction to increase. The plane of nutrition does not consistently affect the soluble nitrogen.

The striking thing about this table is the relation of the rib, round, and loin cuts to each other. The rib is the lowest of the three, with the loin second and the round first. The round is certainly a juicier piece of meat than the loin and the loin is more juicy than the rib. From this table juiciness would appear to be a function of the soluble nitrogen.

The data for the coagulable nitrogen in per cent of the total nitrogen appears in Table XXV. This fraction increases, at least the amount of this fraction is materially higher at 48 months than at birth and there is a tendency for this increase to be gradual. The coagulable nitrogen increases then with age.

TABLE XXV.—COAGULABLE NITROGEN OF FAT-FREE MUSCLES.

In per cent of total nitrogen

Sample	Rib	Round	Loin	Rib	Round	Loin	Rib	Round	Loin
Group	I	I	I	II	II	II	III	III	III
Birth.....	6.828	6.828	6.828	6.828	6.828	6.828	6.828	6.828	6.828
11 mo.	6.097	9.989	9.736	8.739	9.802	9.451	7.743	10.166	9.305
21-26 mo.	7.686	9.624	8.142	7.415	9.226	6.984	7.743	10.166	9.305
34-35 mo.	9.578	7.456	8.767	9.892	9.627	10.400	11.276	10.260	11.562
48 mo.	9.421	10.355	9.547	10.003	9.581	11.047	11.276	10.260	11.562

The coagulable nitrogen has a tendency to increase as the plane of nutrition is lowered. In the Group III this value appears to be highest.

As in the preceding table the values in each of the three groups is highest with the round, second in the loin and lowest in the rib.

The data appearing in Table XXVI are that of the amino acid and extractive nitrogen of the same samples in per cent of the total nitrogen. In general the same fact is shown that appeared with the soluble nitrogen and the coagulable nitrogen. The values for the round are higher than the loin and the loin values are higher than the rib. This difference is only very general in this case and does not appear in so marked a degree as in the other two fractions.

TABLE XXVI.—AMINO ACID AND EXTRACTIVE NITROGEN OF FAT-FREE MUSCLE.

In per cent of total nitrogen

Sample	Rib	Round	Loin	Rib	Round	Loin	Rib	Round	Loin
Group	I	I	I	II	II	II	III	III	III
Birth.....	10.095	10.095	10.095	10.095	10.095	10.095	10.095	10.095	10.095
11 mo.	9.051	9.907	9.652	7.173	7.571	7.412	6.674	8.070	8.261
21-26 mo.	7.742	9.227	8.055	7.473	7.523	7.695	6.674	8.070	8.261
34-35 mo.	6.940	6.854	7.212	6.204	5.572	7.932	7.737	8.653	8.687
48 mo.	6.271	7.774	7.225	6.649	7.017	7.143	7.737	8.653	8.687

This amino acid and extractive nitrogen decreases as the animal matures in Group I and Group II. In Group III, the values tend to remain fairly high. The young animal, in proportion to body weight and surface, has a greater metabolism than the old animal and a higher amino acid and extractive nitrogen is to be expected. In the thin Group III animals the higher amino acid and extractive nitrogen may be due to the breaking down of tissue, though it is doubtful if the treatment has been severe enough to cause the animal to call on its protein for energy.

The coagulable nitrogen in per cent of the soluble nitrogen appears in Table XXVII. As the age increases the value in general increases and as the plane of nutrition is lowered the coagul-

able nitrogen becomes a greater part of the soluble nitrogen. The relation of the round, loin, and rib lean flesh as shown in the preceding tables is not so striking here.

TABLE XXVII.—COAGULABLE NITROGEN OF FAT-FREE MUSCLE.

In per cent of soluble nitrogen

Sample	Rib	Round	Loin	Rib	Round	Loin	Rib	Round	Loin
Group	I	II	III	I	II	III	I	II	III
Birth.....	35.977	35.977	35.977	35.977	35.977	35.977	35.977	35.977	35.977
11 mo.....	42.489	46.811	43.805	48.576	47.275	46.866	42.271	46.362	46.291
21-26 mo....	40.774	42.500	41.864	41.396	42.450	32.065	42.271	46.362	46.291
34-35 mo....	49.263	37.846	45.994	48.217	46.283	47.517	42.271	46.362	46.291
48 mo.....	49.703	48.690	49.407	51.475	45.839	52.044	52.424	49.850	56.522

The amino acid and extractive nitrogen data in per cent of the total nitrogen of these three samples appear in Table XXVIII. Here there is seen a decided decrease from the young to the old animals. As the animal becomes thinner this fraction tends to decrease except with the 48-month-old animals. The decrease of this fraction as the animal matures follows the decrease in the metabolic activity with advancing age. The increase in the smaller nitrogen fraction in the old animals as the plane of nutrition becomes poorer might be due to a call on the protein, though as has been mentioned before, this plane of nutrition is hardly low enough to cause such action.

TABLE XXVIII.—AMINO ACID AND EXTRACTIVE NITROGEN OF FAT-FREE MUSCLE.

In per cent of soluble nitrogen

Sample	Rib	Round	Loin	Rib	Round	Loin	Rib	Round	Loin
Group	I	II	III	I	II	III	I	II	III
Birth.....	53.191	53.191	53.191	53.191	53.191	53.191	53.191	53.191	53.191
11 mo.....	49.626	46.429	43.429	39.873	36.512	36.752	36.435	36.805	41.098
21-26 mo....	41.071	40.750	41.420	41.721	34.615	35.326	36.435	36.805	41.098
34-35 mo....	35.693	34.789	37.834	30.243	26.788	36.242	35.969	42.042	42.464
48 mo.....	33.086	36.552	37.389	34.218	33.568	33.651	35.969	42.042	42.464

From the data presented just above general conclusions may be drawn. The total nitrogen is not seriously affected by condition though Group I is slightly higher than Group II and Group II higher than Group III. There is shown quite a change in the total nitrogen with age. The nitrogen at birth and up to three months appears to be about two-thirds of that at maturity, four years. From three months to eleven months, there is a period of intermediate nitrogen content after which the nitrogen value rises to about that for the mature animal.

The total soluble nitrogen has a slight tendency to increase with age but is not materially affected by the plane of nutrition.

The coagulable nitrogen increases as the animal matures and also as the plane of nutrition is lowered.

In amounts of the two nitrogen fractions preceding, the lean of the round is highest, the loin is second and the rib third. These three cuts of meat follow this order in juiciness and such juiciness may be a function of the soluble nitrogen.

There is a decrease with age of the amino acid and extractive nitrogen fraction. This fraction appears both as the means of the building up of tissue and as the result of tearing it down. As the young animal has a high metabolism in relation to body surface and body weight, a high content in the young animal of this fraction is to be expected. The amount of this form of nitrogen should decrease with age and such is the case. If this fraction appears in an increasing amount with starvation, then we would expect an increased amount in an under-fed aged animal. Such a tendency is shown though it is doubtful if the treatment of this animal has been severe enough to cause such a breaking down of body tissue. The relation of the round, loin, and rib pointed out in the preceding paragraph holds only very generally with this nitrogen fraction. As the animal matures the coagulable nitrogen of the soluble nitrogen increases. It also becomes a larger part as the animal grows poorer. The amino acid and extractive nitrogen becomes a smaller part of the soluble nitrogen both as the animal matures and with the plane of nutrition except in the aged animal.

TABLE XXIX.—NITROGEN DISTRIBUTION IN MATURE STEERS.
(Regular Maintenance Animals)

Animal	Age	Condition	Total nitrogen	In per cent of total nitrogen			In per cent of soluble nitrogen	
				Soluble nitrogen	Coagu- lable nitrogen	Amino acid & extra- ctive nitrogen	Coagu- lable nitrogen	Amino acid & extra- ctive nitrogen
Lean of Round								
18*	30 mos.---	Thin.-----	3.585	18.466	9.233	6.750	50.000	36.556
121*	32 mos.---	Half fat.---	3.575	20.448	9.762	7.860	47.743	38.441
48	57 mos.---	Very fat.---	3.786	20.417	9.958	6.577	48.771	32.221
Lean of Loin								
18	30 mos.---	Thin.-----	3.661	19.202	9.178	5.955	47.795	31.010
121	32 mos.---	Half fat.---	3.395	21.502	10.162	8.630	47.260	40.137
48	57 mos.---	Very fat.---	3.647	20.675	10.474	6.444	50.066	31.167
Lean of Rib								
18	30 mos.---	Thin.-----	3.753	17.558	8.820	5.755	50.228	32.777
121	32 mos.---	Half fat.---	3.521	19.739	9.093	7.640	45.612	38.705
48	57 mos.---	Very fat.---	3.567	18.783	7.990	6.140	42.537	36.687
Lean Composite								
197	39 mos.---	Thin.-----	3.368	18.141	6.443	6.681	35.516	36.825

*These samples are composites of the Round and Rump.

THE EFFECT OF INCREASED PLANE OF NUTRITION ON THIN MATURE ANIMALS

These animals, 18, 121, and 48, it will be recalled from a description earlier in this paper, were steers which had been discarded from a feeding experiment as poor feeders. After wintering on hay they were put on maintenance and later fed out with the exception of 18 which was a thin animal when slaughtered. Animal 121 was a choice steer two years and eight months old when slaughtered, while 48 was greatly overdone and four years and nine months old. The data for the animals appear in Table XXIX.

Total Nitrogen.—It appears from the table that the total nitrogen has not been consistently affected by the plane of nutrition. With the round, the nitrogen increases with the plane of nutrition but with the loin and rib flesh the values remain about constant or decrease somewhat.

Total Soluble Nitrogen.—This fraction tends to increase as the animal becomes fatter, at least the value for the fattest animal is higher in each sample than in the thin animal. A larger part of the total nitrogen is soluble in the loin than in the other samples. The relation of the round, loin and rib does not hold true with these samples for the loin is higher in soluble nitrogen with the round second.

The coagulable nitrogen in the round and loin cuts increases, as the animals fatten but the value for the rib is lower in the fat animal than in the thin one. The loin is highest in this fraction in two of the three animals with the round first in the fat animal and second in the other two.

The amino acid and extractive nitrogen tends to increase with the plane of nutrition. In all three animals this value is largest when the animal is half fat. This fraction decreases again with the very fat animal but only with the round does it drop to the figure for the thin animal. This may be due as has been shown earlier to the diluting effect of the large amount of fat present. The loin is again the highest in two of the three animals with the round highest in one of the three.

In relation to the soluble nitrogen the coagulable nitrogen does not vary materially in the three animals. Generally speaking it is higher in the thinner of the three steers though the differences are not consistently in one direction.

The amino acid and extractive nitrogen varies differently with all three animals and no significant figures are seen in the table.

From these data it appears that the fattening of a mature animal does not materially affect the total nitrogen. Considering the total soluble nitrogen and its fractions there is a tendency for these to increase as the animal is fattened. In no case are these tendencies very pronounced and yet the trend of the values warrants the observation that an increase is the general result of fattening. The relation of the round, loin, and rib lean samples does not hold good in this sample. The loin is higher with two or three exceptions when the round has the higher values. The rib in all samples is the lowest.

Steer 197, it will be recalled, had been fed as a show steer and then kept on maintenance for about two years. In condition, it was much like Steer 18 though somewhat heavier and about nine months older. The total nitrogen (Table XXIX) was lower than the nitrogen of Steer 18 by about 6 per cent. The soluble nitrogen in per cent of total nitrogen is also somewhat lower than that of Steer 18. The significant figure is that for the coagulable which is about 30 per cent less than the coagulable nitrogen for 18. The amino acid and extractive nitrogen is somewhat lower, though hardly enough to be significant.

In terms of the soluble nitrogen the coagulable nitrogen is much lower than in Steer 18, while the amino acid and extractive nitrogen is about the same.

In connection with Special Maintenance it will be shown later in this bulletin that a long period of under nutrition has the effect of reducing the soluble nitrogen. This reduction is about taken care of in the loss of the coagulable nitrogen. While the treatment of 197 was not so severe as with the Special Maintenance animal (592), there is confirmation here of the losses in the form of nitrogen. It appears from these data, that the two years of maintenance has reduced the total nitrogen and that this loss of nitrogen has been largely taken care of by a loss in the coagulable fraction of the soluble nitrogen.

THE EFFECT OF FATTENING THE MATURE DAIRY COW

Animals 63, 4, and 43 were aged Jersey cows. Cow 4 was fattened on a dairy ration and 43 was fattened on a beef ration while 63 was used as a control animal. The data on the nitrogen distribution appear in Table XXX.

Total Nitrogen.—There appears a slight decrease in this value as the animals were fattened but it is too small to be significant.

TABLE XXX.—NITROGEN DISTRIBUTION IN MATURE JERSEY DAIRY COWS.

Animal	Age	Nitrogen	In per cent Total Nitrogen			In per cent soluble nitrogen	
			Soluble nitrogen	Coagu-lable nitrogen	Amino acid & extractive nitrogen	Coagu-lable nitrogen	Amino acid extractive nitrogen
Lean Composite							
63-----	6 yrs.	3.536	18.580	8.456	6.674	45.510	35.921
4-----	9 yrs.	3.518	21.177	8.016	9.892	37.852	46.711
43-----	7 yrs.	3.525	19.035	7.716	8.653	40.537	45.455

Soluble Nitrogen.—A larger part of the total nitrogen appears to be soluble in the better fed animals but of this soluble nitrogen more is coagulable in the thin animal than in the fat ones.

The amino acid and extractive nitrogen shows an increase with the fat animals.

In per cent of soluble nitrogen the coagulable nitrogen is less in the fat animals than in the thin one while with the amino acid and extractive nitrogen the opposite is true.

It is apparent that the two types of rations have had no effect on the nitrogen distribution and the data do not warrant any conclusions as to the effect of the plane of nutrition.

THE EFFECT OF UNDERFEEDING ON THE NITROGEN DISTRIBUTION OF THE COMPOSITE FLESH

A description of these Special Maintenance animals, whose data appear in Table XXXI has been given earlier in this paper.

Calculation of Data.—The data on the composite flesh have been calculated from those of the lean flesh and fat flesh. It will be remembered that Animal 592 was in very poor condition and was very weak. When slaughtered his flesh appeared as lean flesh yet there must have been some fatty residues there. For this reason the sample of Steer 592 must be considered as a lean and fat composite sample. It was therefore necessary to calculate the other samples as for a lean and fat composite. The data have been published by C. R. Moulton¹² of this Experiment Station in another connection. There has appeared in this paper a statement that lean and fat flesh should not be composited especially in fat animals because of the diluting effect of so much fat. In this case the calculation of such a composite was necessary in order that comparisons could be made between the animals and 592. That such a calculation of a composite was justified in this instance has been shown on page 37 where it is stated that the differences would have been more striking than they are if the fat had been left out.

TABLE XXXI.—NITROGEN DISTRIBUTION—LEAN AND FAT COMPOSITE.
(Special Maintenance Animals)

Class	Control	Super-Mainten- ance	Mainten- ance	Mainten- ance	Sub-Mainten- ance	Sub-Mainten- ance
Animal	594	593	597	595	591	592
Condition Age	Fat 11 mos.	Fat 17 mos.	Fairly fat 17 mos.	Thin 23 mos.	Very thin 17 mos.	Very very thin 21 mos.
Nitrogen	3.585	3.299	3.361	3.367	3.343	3.180

In per cent of total nitrogen.

Soluble nitrogen	17.930	17.120	18.410	17.070	18.630	14.680
Coagulable Albumose & peptone nitrogen	8.170	6.690	7.230	7.780	8.340	4.810
Amino acid extractive nitrogen	3.430	4.000	4.550	2.730	3.504	3.420
	6.330	6.420	6.630	6.560	6.730	6.440

In per cent of soluble nitrogen.

Coagulable nitrogen	45.570	39.077	39.272	45.577	44.767	32.766
Amino acid extractive nitrogen	35.304	37.500	36.013	38.430	36.125	43.869

Total Nitrogen.—Steer 594, the check animal, has distinctly a higher nitrogen content than the other animals. The animals 593, 597, 595, and 591 have a lower but rather uniform nitrogen content in the composite flesh. In Steer 592, the animal which received such severe treatment that it was hardly able to get around, the drop in the nitrogen content is still greater. This animal, 592, had been so severely treated that it was beginning to draw on its protein supply for energy. Its fat content had been reduced to 1.87 per cent and the animal had to get its supply of energy elsewhere and its protein tissue was beginning to suffer.

Soluble Nitrogen.—This fraction, with the exception of animal 592, is about constant. It varies from 17.07 to 18.63 for five of the animals. The striking value is that for the soluble nitrogen of 592 which has dropped to 14.68 per cent of the total nitrogen. The severe treatment to which this animal had been subjected has plainly reduced the proportion of soluble nitrogen. In its effort to maintain itself, this animal was drawing on the supply of soluble nitrogen in its flesh. This fact would account for the tough, stringy and flavorless meat from the very thin animal.

It can be seen from Table XXXI that the decrease in the value for the soluble nitrogen can be almost entirely accounted for by the coagulable nitrogen. Steer 592 is over 40 per cent lower than the check animal 594.

The effect, then, of a low plane of nutrition in the nitrogen distribution in the flesh of beef animals is not only a reduction in the total nitrogen but a diminution in the amount of soluble nitrogen and this lower amount of soluble nitrogen seems from these data to be accounted for by the coagulable nitrogen fraction.

In Table XXXI is also shown the data for the coagulable nitrogen and the amino acid and extractive nitrogen, in per cent of the total soluble nitrogen. Steer 592 shows a much lower value for coagulable nitrogen and a higher value for amino acid and extractive nitrogen. Not only has partial starvation reduced the proportion of soluble nitrogen but the proportion of the fractions composing it have been altered. The coagulable nitrogen has been removed more rapidly than the total soluble nitrogen. The increase in proportion of amino acid and extractive nitrogen may be a result of this same process for the proportion of this fraction in the total remains fairly constant (Table XXXI).

SUMMARY

The study of the nitrogen and its distribution in the lean flesh of the round, rib, and loin, showed that the total nitrogen does not materially change with the condition of the animal. The change seems to be rather the result of age, for the nitrogen increases with age in apparently three periods. The first period ends at about the age of three months, the second extends from three to twelve months and the third lasts from twelve months to maturity.

The soluble nitrogen of the lean flesh tends to become a larger part of the total nitrogen as the animal matures. The coagulable nitrogen also increases with age. These two fractions of the nitro-

gen in the lean flesh tend to decrease as the plane of nutrition is lowered. The amino acid and extractive nitrogen decrease with age.

In per cent of soluble nitrogen, the coagulable nitrogen increases with age while the amino acid and extractive nitrogen decreases as the animal matures.

The significant changes have come in the young animals and when one considers the old animals different results are seen. The total nitrogen of the mature steers which were fattened does not materially change though the youngest animal which is also the thinnest has the lowest value for nitrogen.

The soluble nitrogen of these fat mature steers increased as the animal became fatter. In the young animals it was apparent that the changes in soluble nitrogen were a result of age and not so much a result of condition. These mature steers were in little better condition than the Group III animals and were then fattened. The steers increased their soluble nitrogen both with age and condition. Undoubtedly some of this soluble nitrogen came with condition but at the same time, age must have had its effect.

The coagulable nitrogen in per cent total nitrogen in both the lean samples of the young animals and in the samples of the mature steers increases with age. In the former this value increases as the plane of nutrition is lowered and with the mature steers the coagulable nitrogen increases. This increase must be a result of age and not so much the effect of condition.

The amino acid and extractive nitrogen values of these two groups of animals appear to be contradictory. The lean samples in Groups I and II decrease with age and are highest in this value in Group III while with the mature steers there appears an increase with age and condition.

With the fattened dairy cows no significant change is apparent though the results tend to follow the results of the mature steers. There is no significant change in the total nitrogen either as a result of age or condition. The soluble nitrogen is highest in the oldest animal which is not the fattest of the three. This is a confirmation of the statement in the preceding paragraphs that the increases are due to age rather than condition. The amino acid and extractive nitrogen shows this tendency while the coagulable nitrogen shows the highest value for the youngest animal with the second in age the lowest.

These changes have all been due in a general way to the age of the animal. With the Special Maintenance animals the significant change is due to a change in condition (partial starvation).

The nitrogen values for Steer 592 are the remarkable figures. Using the control animal 594 as a basis of comparison, the total nitrogen has fallen off ten per cent in 592 and yet 592 is ten months older than 594. This decrease was largely due to a decrease in the soluble nitrogen and this is accounted for by the coagulable nitrogen. Here is a change which is a result of the condition of the animal and not of the age, for Steer 592 is ten months older than 594, the control animal.

Additional evidence of the tendency of a period of starvation to withdraw the soluble nitrogen from the flesh is seen in the data of Steer 197 (Table XXIX). This animal has had by no means the severe treatment to which 592 was subjected but the two years of maintenance must have had its effect for the coagulable nitrogen is 30 per cent lower than an animal of similar condition though it is somewhat younger.

PART II.—ASH AND PHOSPHORUS

The data concerned in the following discussion are calculated to the fat free or protoplasmic basis and have been brought forward from Tables 10-18 of the Appendix. Not all the animals used in the nitrogen comparisons will be used here but only those of the important groups.

THE COMPARISON OF THE COMPOSITION OF LEAN MUSCLE AND FATTY TISSUE

Total Ash and Soluble Ash.—Table XXXII presents the data for the lean composite and the fat composite of the Special Maintenance animals. The total ash does not vary significantly in the lean composites or in the fat composites. However, the ash is about 20 per cent higher in the lean tissue than in the fatty tissue. This is to be expected, however, when one thinks of the make-up of these two kinds of tissue.

The soluble ash in per cent of the total ash in the lean does not show any effect of either age or the plane of nutrition. Steer 592, the thinnest animal, is only just a little lower in soluble ash than the fat animal. This steer is likewise one of the oldest and yet this fraction of the ash is about the same as in the check animal. There

TABLE XXXII.—ASH AND PHOSPHORUS OF LEAN MUSCLE AND FATTY TISSUE.
(FAT-FREE.)
(Special Maintenance Animals)

Animal	Age	Condition	Total ash	Soluble ash % of total	Total phosphorus	Soluble phosphorus % of total phosphorus	Soluble organic phosphorus
Lean Composite							
592	21 mo.---	Very, very thin.-----	1.065	85.164	.177	73.446	19.209
591	17 mo.---	Very thin.-----	.954	90.566	.193	83.347	47.150
595	23 mo.---	Thin.-----	1.048	77.290	.206	78.155	68.932
597	17 mo.---	Fairly fat.-----	1.015	82.956	.195	78.974	60.513
593	17 mo.---	Fat.-----	1.094	63.314	.200	73.000	55.000
594	11 mo.---	Fat.-----	1.058	91.034	.207	76.812	75.362
Fat Composite							
591	17 mo.---	Very thin.-----	.828	33.575	.138	30.435	19.565
595	23 mo.---	Thin.-----	.956	52.824	.134	52.239	40.299
597	17 mo.---	Fairly fat.-----	.785	58.217	.129	48.062	29.457
593	17 mo.---	Fat.-----	.561	92.692	.197	100.000	36.041
594	11 mo.---	Fat.-----	.832	60.681	.162	66.049	59.259

is considerably less of the ash of the fatty tissue soluble than in the lean tissue. One would expect however that the ash of the lean would not only be higher but also more of it soluble than the ash of the fatty tissue. Just why the fatty tissue of 591 has only 33 per cent of soluble ash and 593 has 92 per cent is not evident.

Phosphorus.—The phosphorus of the lean muscle is much higher than in the fatty tissue. Only in such samples as nervous tissue, glands, or bone, would we expect a higher per cent of phosphorus than in the lean muscle. The thin animals 592 and 591 appear to have a smaller amount of phosphorus than the better fed animals.

The soluble phosphorus in per cent of total phosphorus in the lean muscle is higher than the same fraction in the fatty tissue. The effect of a low plane of nutrition seems negligible, for 591, a thin animal, has the highest per cent of its phosphorus soluble, while 592 a very thin animal and 593 a fat animal of about the same age are almost the same. In the fatty tissue the lowest value for the soluble ash is with the thin animal, 591. Steer 593, following its high soluble ash content in the fatty tissue, appears to have all its phosphorus soluble. Too much faith should not be put in this one result since 597, a fat animal of the same age, and 594, the check animal of the same condition and less age, have only about half of this amount.

The soluble organic phosphorus of the lean muscle appears, from the data in Table XXXII, to have been somewhat affected by the plane of nutrition. Steer 592, the very thin animal, has only

19 per cent of its phosphorus in the form of the soluble organic phosphorus while the check animal, 594, has 75 per cent. Steer 591, a thin animal but less severely treated than 592, has also a smaller amount than any of the others. Considering the soluble organic phosphorus of the fatty tissue, 591 has a much smaller amount of its phosphorus in this form than the other animals. These reduced amounts would appear to be the result of the plane of nutrition rather than a result of age. On the whole the lean muscle has a greater per cent of soluble organic phosphorus than does the fatty tissue.

Table XXXII shows that there is a considerable difference in ash and phosphorus of these two kinds of tissue. The lean muscle has a greater amount of ash than the fatty tissue of which a larger amount is soluble. The lean muscle has also a greater amount of phosphorus than the fatty tissue and of this phosphorus more of it is soluble and in the form of soluble organic phosphorus than in the fatty tissue. The ash does not appear to change with age or plane of nutrition. Neither does the total phosphorus or the soluble phosphorus. The soluble organic phosphorus increases as the animal fattens. Steer 592 appears to have an abnormally low value for soluble organic phosphorus. This would appear to be due to partial starvation.

LEAN AND FAT FLESH OF RIB

Total Ash and Soluble Ash.—The data for the ash and the soluble ash in per cent of the total ash appears in Table XXXIII. In these samples, the total ash is higher in the fatty tissue than in the lean muscles in practically all the animals. This is probably not

TABLE XXXIII.—ASH—USE OF FOOD ANIMALS.
Fat-Free Basis.

Age	Total ash			Soluble ash In per cent of total		
	I	II	III	I	II	III
Lean of Rib						
At birth.....	1.031	1.031	1.031	78.274	78.274	78.274
11 mo.	1.041	1.033	-----	109.99	93.804	-----
21-26.....	1.088	1.022	1.070	88.051	79.843	63.458
34-35.....	1.066	1.067	-----	82.552	86.223	-----
48-mo.....	1.0192	1.053	1.060	-----	-----	-----
Fat of Rib						
11 mo.	1.143	.962	-----	31.759	69.127	-----
21-26 mo.....	1.043	1.125	1.576	74.209	60.889	52.919
34-35 mo.....	1.144	1.074	-----	22.727	51.210	-----

typical of the difference between lean and fat tissue. By referring to the round and loin lean and fat samples in the Appendix it will be seen that these samples confirm the results found under the lean and fat composites of the Special Maintenance steers, and that the fatty tissues contain a smaller percentage of ash. However, the per cent of this ash that is soluble is greater in the lean muscle than in the fatty tissue. It is difficult to point out significant effects of either age or plane of nutrition. In the instances where there are results for three groups, the soluble ash becomes less as the plane of nutrition is lowered in both kinds of tissues. The soluble ash of the lean of rib for the old animals and the soluble ash of the rib fat of the 11-month and 35-month-old animals increases with lowered plane of nutrition while it decreases with the lean muscle of the 11- to 26-month-old animals.

Phosphorus.—The total phosphorus of the lean muscle of the rib (Table XXXIV) does not appear so much higher than the phosphorus of the fat of the rib though there is an appreciable difference between most of the samples. In general it seems that the phosphorus in both the lean muscle and fatty tissue decreases with age except in the Group III animals. Here only one comparison is possible so conclusions are hardly justified. The plane of nutrition seems to have no consistent effect.

TABLE XXXIV.—PHOSPHORUS OF USE OF FOOD ANIMALS, ON FAT-FREE BASIS.

Age	Total phosphorus			Total soluble phosphorus In per cent of total			Soluble organic phosphorus In per cent of total		
	I	II	III	I	II	III	I	II	III
Lean of Rib									
Birth.....	.180	.180	.180	72.778	72.778	72.778	36.667	36.667	36.667
11 mo.	.218	.206	---	73.395	75.243	---	61.927	75.243	---
11-26 mo.	.202	.196	.198	76.733	78.061	77.778	52.970	40.306	67.677
24-35 mo.	.191	.198	---	81.818	94.444	---	58.639	63.636	---
48 mo.	.192	.185	.194	65.104	64.865	80.928	50.521	48.108	63.918
Fat of Rib									
11 mo.	.226	.185	---	72.556	75.135	---	45.575	73.514	---
21-26 mo.	.160	.168	.240	45.000	51.190	34.583	48.125	27.381	20.417
34-35 mo.	.171	.178	---	54.971	66.853	---	74.854	66.854	---

The part of this phosphorus that is soluble in these two kinds of tissue is greater with the lean than with the fat. As the animals mature the soluble phosphorus in the lean muscle seems to increase with the exception of Groups I and II of the 4-year-old animals. The values here are decidedly less. With the fatty tissue, this condition is reversed and the young animals have higher values than the older animals. Considering the plane of nutrition, we find the soluble phosphorus increasing as the animals become thinner.

There is considerable variation in the soluble organic phosphorus in per cent of total phosphorus in both the lean muscle and the fatty tissue of the rib. At birth but one-third of the phosphorus appears as soluble organic phosphorus in the lean muscle. At eleven months the value is 62 to 75 per cent. Later the percentage is less. With the fatty tissue this form of phosphorus increases in Group I with age. In Group II there is a decided falling off of the soluble organic phosphorus in the 26-month-old animal, while at 35 months the value is high again. This falling off and subsequent rise coincide with a similar condition in the lean muscle. The soluble organic phosphorus in the lean muscle increases in some cases as the plane of nutrition is lowered though in two instances Group II animals have a smaller value than Group I. However, in Group III the values at this age are greater than Group I. In the fatty tissue the soluble organic phosphorus decreases as the animals become thinner with the exception of the 11-month-old steers.

Summarizing, there appears only a little larger amount of ash in the lean muscle than in the fatty tissue but of this more is soluble in the lean muscle and a greater proportion is in the organic form. The soluble phosphorus in the lean muscle increases as the animal becomes thinner. This is in confirmation of the work of Francis and Trowbridge¹³ who found that the "flesh of a thin animal contained more soluble phosphorus than that of a fat animal".

MIXED LEAN AND FAT COMPOSITES

Ash and Soluble Ash.—The ash and the soluble ash of the lean and fat composites of the Use of Feed animals appears in Table XXXV. Age or plane of nutrition do not seem to affect the total ash. The soluble ash in per cent of the total seems to increase as

TABLE XXXV.—ASH OF LEAN AND FAT COMPOSITES, (FAT-FREE).—USE OF FOOD ANIMALS.

Age	Total ash Per cent			Soluble ash In per cent of total		
	I	II	III	I	II	III
At birth.....	1.031	1.031	1.031	78.274	78.274	78.274
3 mo.....	1.283	1.257	1.087	57.768	71.201	86.569
5½ mo.....	1.292	1.135	1.095	63.932	73.304	77.169
8½ mo.....	1.094	1.056	1.006	77.697	81.723	85.685
11 mo.....	1.129	1.136	1.102	82.374	83.627	84.392
17-18 mo.....	1.157	-----	1.218	87.727	-----	89.491
40 mo.....	1.073	1.093	1.102	-----	-----	-----
45 mo.....	1.088	1.029	1.039	66.636	80.564	77.189

the plane of nutrition becomes lower. The higher value at the beginning is from a composite sample of new-born calf and is practically a lean sample. The next value is lower but thereafter the

soluble ash increases with age. In the 45-month-old animals, however, especially the Group I animal, there is a decided loss in the soluble ash. In the discussion of the nitrogen distribution in these same animals, it is suggested that the loss which occurs in the nitrogen of the old animals is due to a dilution by the fatty tissue. There is considerable fatty tissue mixed in with these composite samples especially with the old Group I animals. While the dilution of the ash is not so great as with the nitrogen, still it is thought that these lower values might be charged to such a dilution. It is apparent that the practice of mixing lean and fat samples together should be stopped if results of value are to be obtained.

Phosphorus.—In the per cent of total phosphorus of these Use of Food animals there seems to be no effect of age or plane of nutrition. (Table XXXVI). At 45 months the samples have a greater phosphorus content than in the calf at birth but there is much variation in between. There seems to be no definite conclusion as to the effect of the plane of nutrition. In half the ages presented Group III is higher than Group I and in the other half Group III is lower than Group I.

TABLE XXXVI.—PHOSPHORUS OF LEAN AND FAT COMPOSITES, ON FAT-FREE BASIS.
(Use of Food Animals)

Age	Total phosphorus per cent			Total soluble phosphorus In per cent of total phosphorus			Total soluble organic phosphorus In per cent of total phosphorus		
	I	II	III	I	II	III	I	II	III
At birth.....	.180	.180	.180	72.778	72.778	72.778	36.667	36.667	36.667
1 mo.....	.196	.201	.193	72.449	70.647	71.503	14.286	15.423	9.845
5 ½ mo.....	.200	.187	.198	37.500	42.246	39.394	17.500	17.112	11.111
8 ½ mo.....	.197	.207	.204	11.675	71.498	70.588	37.060	32.850	26.471
11 mo.....	.212	.205	.191	75.943	81.463	79.581	46.698	36.098	52.880
17-18 mo.....	.209	—	.227	71.770	—	67.401	41.148	—	41.410
40 mo.....	.191	.186	.201	51.309	68.280	70.647	15.183	43.011	25.871
45 mo.....	.194	.195	.194	61.856	62.564	71.134	30.928	46.154	51.546

The soluble phosphorus in per cent of the total phosphorus shows but little as to the effect of either age or plane of nutrition. At 45 months, the values in all three groups are somewhat less than the calf at birth. But in between these values the percentages vary above and below to the extent that it is hardly possible to attempt any conclusions.

The values of the soluble organic phosphorus do not follow any particular order as a result of either age or plane of nutrition. In Groups II and III the values are higher with the 45-month-old animals than with the calf at birth. The values consistently drop with

the 3-month-old animals but the rise from there on follows no order. In about half the animals there is a loss as the plane of nutrition is lowered and with the other half there is a rise.

In these values for ash and phosphorus of the mixed lean and fat composites there is no effect shown by either age or plane of nutrition. The results are varied and follow no logical order. Whether or not these results are due to a mixing of lean and fat samples is not definite but it seems that these results would show that such a practice should be condemned.

THE COMPARISON OF THE LEAN FLESH OF THE RIB, ROUND, AND LOIN

In Tables XXXVII and XXXVIII are found the data from pure lean samples which should allow a study of the effect of age and the plane of nutrition unhampered by the effect of more or less fatty tissue. These samples are taken from certain of the Use of Feed animals.

TABLE XXXVII.—ASH IN FLESH OF USE OF FOOD ANIMALS, ON FAT-FREE BASIS.

Age	Round			Rib			Loin		
	I	II	III	I	II	III	I	II	III
Total Ash									
At birth.....	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031	1.031
11 mo.....	1.078	1.076	-----	1.041	1.033	-----	1.070	1.074	-----
21-26 mo.....	1.083	1.067	1.090	1.088	1.070	1.070	1.088	1.028	1.986
34-35 mo.....	1.039	1.041	-----	1.066	1.067	-----	1.172	1.058	-----
48 mo.....	1.056	1.073	1.048	1.019	1.053	1.060	1.037	1.025	1.095
Soluble Ash in per cent of Total									
At birth.....	78.274	78.274	78.274	78.274	78.274	78.274	78.274	78.274	78.274
11 mo.....	107.161	101.58	-----	109.99	93.804	-----	114.953	100.651	-----
21-26 mo.....	100.646	70.291	89.266	88.051	79.843	63.458	91.930	84.630	71.547
34-35 mo.....	81.136	98.943	-----	82.552	86.223	-----	85.573	93.573	-----
48 mo.....	-----	-----	-----	-----	-----	-----	-----	-----	-----

TABLE XXXVIII.—PHOSPHORUS IN FLESH OF USE OF FOOD ANIMALS, ON FAT-FREE BASIS.

Age	Lean of round			Lean of rib			Lean of Loin		
	I	II	III	I	II	III	I	II	III
Total Phosphorus									
At birth.....	.180	.180	.180	.180	.180	.180	.180	.180	.180
11 mo.....	.221	.214	-----	.218	.206	-----	.218	.208	-----
21-26 mo.....	.214	.207	.210	.202	.196	.198	.206	.192	.207
34-35 mo.....	.199	.204	.191	.191	.198	-----	.213	.201	-----
48 mo.....	.204	.201	.198	.192	.185	.194	.199	.191	.200
Total Soluble Phosphorus in per cent of total									
At birth.....	72.778	72.778	72.778	72.778	72.778	72.778	72.778	72.778	72.778
11 mo.....	76.471	79.439	-----	73.395	75.243	-----	76.147	81.250	-----
21-26 mo.....	92.991	76.329	77.143	76.733	78.061	77.778	67.961	88.541	79.710
34-35 mo.....	82.915	78.431	-----	81.818	94.444	-----	76.995	77.612	-----
48 mo.....	72.059	70.149	67.714	65.104	64.865	80.928	71.860	71.204	73.500
Soluble Organic Phosphorus									
At birth.....	36.667	36.667	36.667	36.667	36.667	36.667	36.667	36.667	36.667
11 mo.....	48.416	80.374	-----	61.927	75.243	-----	40.829	80.288	-----
21-26 mo.....	47.664	61.836	58.571	52.970	40.306	67.677	40.291	57.812	64.251
34-35 mo.....	68.824	58.824	-----	58.639	63.636	-----	56.808	66.619	-----
48 mo.....	47.059	24.876	57.071	50.521	48.108	63.918	44.221	55.497	55.500

Ash and Soluble Ash.—The data for the ash and soluble ash in per cent of total ash appear in Table XXXVII. These three samples are strictly lean samples and any differences because of age or plane of nutrition should appear here. There are no great variations in the total ash. The values for these three samples range from about 1.02 per cent to 1.09 per cent. The high and low values appear somewhat equally divided between Groups I, II, and III, and it would appear that the total ash is not affected by age or plane of nutrition.

While the percentages of soluble ash in the total ash for these lean samples are somewhat varied, they are consistent in each of the three samples. At 11 months the per cent of soluble ash is higher in all the groups where there are data than in the calf at birth (a composite flesh sample). From this high value the percentages drop as the animal ages to 21 months. As the animals grew to 34 months of age the Group I animals still lost in soluble ash while the thinner Group II animals gained in soluble ash. The young animals, up to 2 years, seem to lose in per cent soluble ash as the plane of nutrition is lowered; while at 3 years the animals gain in soluble ash as the plane of nutrition is lowered. Lack of data in Group III at this age and in all groups at 48 months permits no additional confirmation of these tendencies.

Phosphorus.—Evidence that the age or plane of nutrition has had any marked effect on the total phosphorus in the lean muscle of these animals is lacking in Table XXXVIII. At 11 months the values are higher in the three samples in all the groups than at 48 months or at birth. They are not enough higher than the former, however, to be much more than an indication, and do not justify definite conclusions.

Francis and Trowbridge¹³ have reported that the lean flesh of the thin animals contains more soluble phosphorus than the fatter animals. The basis of their report was in the animals 21 to 26 months old shown in Table IV. From the data of Table XXXVIII calculated on a fat-free basis this is not borne out in the case of the round but the rib and loin in general confirm their conclusion. The evidence of an effect of the plane of nutrition is somewhat contradictory and the evidence of an age effect seems equally unsatisfactory. There does appear to be a time of a higher soluble phosphorus content somewhere between 21 and 35 months. The fact that the sample at birth is a composite may be responsible for the uncertain evidence.

There is some evidence of an effect of the plane of nutrition in the soluble organic phosphorus. The general tendency is toward a higher value in the Group III animals. In all cases where data are reported for Group III the value for soluble organic phosphorus is higher than in the Group I animal. In the six cases where only values for Group I and II are reported for this form of phosphorus five of the values for Group II are higher than that of Group I. In considering the effect of age, conclusions seem unjustified, though it will be noticed that all the 48-month-old animals show a lower value for soluble organic phosphorus than the 11-month-old animals with but one exception. These differences appear to be largest in the Group II animals.

From the data of Table XXXVII, it appears that the age and plane of nutrition have little or no effect on the amount of ash and soluble ash of the lean muscle of the round, loin, and rib cuts.

The total phosphorus appears to decrease in amount as the animal ages but the evidence is far from satisfactory. The report of Francis and Trowbridge that the thin animal has a greater amount of soluble phosphorus than a fat animal is confirmed by the data from two out of three sets of samples.

The soluble organic phosphorus appears to increase somewhat as the animal becomes thinner but there is no significant effect of age. It is doubtful if the evidence is sufficient to say that the soluble organic phosphorus increases as the plane of nutrition is lowered.

THE EFFECT OF UNDERFEEDING ON THE COMPOSITE FLESH

In the discussion of the nitrogen distribution the composite flesh of the Special Maintenance animals was used. This was done for the reason that the sample of 592 was really a composite sample. While it had 1.87 per cent of fat this could not be hand separated and it was therefore not accurately comparable to the other samples. The composite flesh was therefore calculated for the rest of the animals. Since the severe treatment of 592 led to very striking results, it is thought well to include these comparisons here.

Ash.—From Table XXXIX there appears to be no effect on the ash of the severe treatment of 592. It has an ash content even higher than the check animal 594. The per cent of soluble ash shows no effect of either age or plane of nutrition.

Phosphorus.—The total phosphorus is appreciably lower in 592 than that of the check animal 594 or any of the rest of the animals. Francis and Trowbridge¹³ report that the "bulk of the phosphorus

TABLE XXXIX.—ASH AND PHOSPHORUS IN COMPOSITE FLESH, ON FAT-FREE BASIS.

(Special Maintenance Animals)

Animal.....	594	592	591	595	597	593
Condition.....	Fat	Very, very thin	Very thin	Thin	Fairly fat	Fat
Age.....	11 mo.	21 mo.	17 mo.	23 mo.	17 mo.	17 mo.
Total Ash.....	1,045	1,054	,946	1,044	,993	1,009
Soluble ash per cent of total.....	89,952	86,053	87,315	74,234	81,067	61,249
Total phosphorus.....	,205	,176	,190	,203	,188	,201
Soluble phospho- rus per cent of total.....	76,098	73,864	78,947	76,847	77,660	74,129
Soluble organic phosphorus, per cent of total.....	74,634	19,261	44,737	67,980	59,643	53,234

is in the lean flesh and connective tissue and very little in the fatty tissue". If then a lean sample such as the flesh of 592 has less than the check animal 594, a fat steer, then it might be construed that such a reduction is the result of a plane of nutrition, in this case partial starvation.

The soluble phosphorus shows no effect of this low plane of nutrition for 592 has only just a very little less soluble phosphorus than 594 or any of the other steers.

The striking figure is the soluble organic phosphorus of 592. It is apparent that it has only a little more than 25 per cent as much soluble organic phosphorus as 594. Compared with an animal of the same age as 592 and of the condition of 594 (see Table XXXVIII, Steers 21 mos. Group I) it appears that 592 should have a soluble organic phosphoric content of about 40 per cent or somewhere near the value of 591. Instead it has a value of 19.261 per cent and it seems that this is the result of a low plane of nutrition (partial starvation).

SUMMARY

The ash of the fat of the rib on the fat-free basis appears to be higher than the ash of the lean of the rib. However of this ash considerably more of the ash of the lean is soluble than the ash of the fat. The effect of either age or plane of nutrition seems negligible.

The total phosphorus is much higher in the lean of the rib than in fat of the rib. This would be expected as the lean contains con-

siderable phosphorus in both organic and inorganic form. The fat contains a relatively small amount of phosphorus.

The soluble phosphorus in relation to the total phosphorus tends to increase as the animals grow thinner.

The soluble organic phosphorus of the rib lean increases as the animal becomes thinner and decreases somewhat with age, while in the fatty tissue this form of phosphorus appears not to change much with age. As the animals grow thinner the soluble organic phosphorus seems to decrease. However the amount of data is not large enough to justify definite conclusions.

In the mixed lean and fat composites of the Use of Food animals the ash is not greatly affected by age or plane of nutrition. However there is somewhat of a rise in the older animals. The soluble ash does increase somewhat as the plane of nutrition is lowered.

Here again, as in the nitrogen, we see the effect of mixing a large amount of fat with the lean samples. The evidence in both the nitrogen and ash appears strong enough to condemn this practice rather severely. When one is attempting to study an active functioning tissue as protein tissue it is a mistake to mix in such an inert tissue as the fatty tissue which can only have the effect of masking the changes in the active tissue. The phosphorus compounds in this lean and fat composite do not seem to have been affected by either age or plane of nutrition; and with the large amount of fat that is present in the Group I animals, especially, differences would probably be of little value.

In the lean of the round, rib, and loin we have samples of one kind undiluted with fat and in such samples as these there should be shown the effect of age and plane of nutrition. The total ash does not appear to change with either of these factors. The soluble ash of the fat animal decreases with age while in the thin animals the opposite is true. With the plane of nutrition as a factor the steers appear to lose in soluble ash as the plane of nutrition is lowered.

The total phosphorus of these lean samples shows no significant effect of age or varied plane of nutrition though the tendency is for this fraction to become less in the round and rib as the plane of nutrition is lowered but not with the loin. The soluble phosphorus does not appear to have been affected by these two conditions, though there is a fairly consistent high value with all the animals at about two years of age. The evidence that the soluble

phosphorus is greater in the thin animals than in the fat animals appears somewhat contradictory. However, it is true in two-thirds of the cases. The soluble organic phosphorus increases in these three lean samples as the animals become thinner and, while there is some diminution of this value with age, such a change is not of importance.

The ash of the lean and fat flesh of the Special Maintenance animals is larger in amount in the lean muscle than in the fatty tissue and of this more is soluble in the lean flesh. The effect of either age or plane of nutrition on the ash in these two kinds of tissue is not apparent.

The per cent of phosphorus is higher in the lean flesh than in the fatty tissue and more of it is soluble in the lean than in the fat flesh. The soluble organic phosphorus is greater in amount in the lean flesh. The significant figure for the phosphorus of these animals is the soluble organic phosphorus of Steer 592. This is the steer that showed such a marked effect of the plane of nutrition in the nitrogen distribution. It would seem that here again is the effect of a very low plane of nutrition (partial starvation). The soluble organic phosphorus is only 25 per cent of that of 594, the check animal. The total phosphorus has been considerably reduced by this partial starvation. While the total soluble phosphorus is only reduced about 5 per cent, the soluble organic phosphorus has been lowered about 50 per cent from an animal of the same age but of the condition of 594.

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APPENDIX

TABLE 1.—COMPOSITION OF THE LEAN COMPOSITE—SPECIAL MAINTENANCE ANIMALS.

(All determinations reported in Tables 1 to 9 were made on fresh and fat-containing basis.)

Animal	Age	Condition	Water	Fat	Ash	Phosphorus	Nitrogen
594	11 mos.	Fat.....	71.31	6.88	0.985	0.193	3.281
592	21 mos.	Very, very thin.....	76.37	1.87	1.045	0.174	3.150
591	17 mos.	Very thin.....	74.24	2.78	0.927	0.188	3.236
595	23 mos.	Thin.....	73.52	4.91	0.997	0.196	3.171
597	17 mos.	Fairly fat.....	71.29	8.54	0.928	0.178	3.017
593	17 mos.	Fat.....	71.40	6.21	0.979	0.188	3.033

TABLE 1.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid & extractive nitrogen
594	5.09	0.900	0.148	0.145	0.619	0.283	0.222
592	4.21	0.890	0.128	0.033	0.463	0.152	0.203
591	5.18	0.840	0.153	0.088	0.631	0.283	0.225
595	4.98	0.770	0.153	0.135	0.559	0.255	0.218
597	4.96	0.770	0.141	0.108	0.592	0.230	0.215
593	4.54	0.620	0.137	0.103	0.546	0.214	0.205

TABLE 2.—COMPOSITION OF THE FAT COMPOSITE—SPECIAL MAINTENANCE ANIMALS.

Animal	Age	Condition	Water	Fat	Ash	Phosphorus	Nitrogen
594	11 mos.	Fat.....	20.05	72.90	0.231	0.044	1.241
591	17 mos.	Very thin.....	42.37	37.60	0.516	0.086	2.214
595	23 mos.	Thin.....	36.79	48.54	0.492	0.069	2.081
597	17 mos.	Fairly fat.....	25.49	62.82	0.292	0.048	1.473
593	17 mos.	Fat.....	19.99	73.10	0.151	0.053	1.112

TABLE 2.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid & extractive nitrogen
594	0.890	0.140	0.029	0.026	0.079	0.033	0.015
591	1.710	0.173	0.026	0.017	0.152	0.065	0.075
595	1.480	0.260	0.036	0.028	0.160	0.068	0.028
597	.890	0.170	0.023	0.014	0.128	0.059	0.040
593	.700	0.140	0.053	0.019	0.095	0.034	0.032

TABLE 3.—COMPOSITION OF THE RIB LEAN—USE OF FOOD ANIMALS
Fresh and Fat-Containing Basis.

Animal	Group	Age	Water	Fat	Ash	Phos- phorus	Nitrogen
505	I	11 mo.-----	61.76	19.19	0.841	0.176	2.964
503	II	11 mo.-----	69.68	10.23	0.927	0.185	3.154
504	I	21-26 mo.-----	63.28	17.52	0.831	0.167	2.940
523	II	21-26 mo.-----	70.28	9.30	0.927	0.178	3.119
525	III	21-26 mo.-----	70.51	8.66	0.977	0.181	3.161
515	I	34-35 mo.-----	61.18	20.39	0.849	0.152	2.776
507	II	34-35 mo.-----	67.44	12.24	0.937	0.174	2.999
501	I	48 mo.-----	58.89	22.41	0.791	0.149	2.759
512	II	48 mo.-----	65.12	14.53	0.896	0.157	2.967
500	III	48 mo.-----	67.14	12.32	0.929	0.170	3.196

TABLE 3.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
505	4.94	0.925	0.129	0.109	0.565	0.240	0.268
503	4.93	0.870	0.139	0.139	0.567	0.276	0.226
504	4.63	0.790	0.128	0.088	0.554	0.226	0.228
523	4.58	0.740	0.139	0.072	0.559	0.231	0.233
525	4.71	0.620	0.141	0.122	0.579	0.245	0.211
515	4.64	0.700	0.129	0.089	0.540	0.266	0.193
507	5.39	0.816	0.164	0.111	0.615	0.297	0.186
501	-----	-----	0.097	0.075	0.523	0.260	0.173
512	-----	-----	0.102	0.076	0.577	0.297	0.197
500	-----	-----	0.138	0.109	0.687	0.360	0.247

TABLE 4.—COMPOSITION OF THE RIB FAT—USE OF FOOD ANIMALS.

Animal	Group	Age	Water	Fat	Ash	Phos- phorus	Nitrogen
505	I	11 mo.-----	10.91	85.39	0.167	0.033	0.643
503	II	11 mo.-----	23.29	66.74	0.318	0.061	1.481
504	I	21-26 mo.-----	14.42	80.63	0.202	0.031	0.833
523	II	21-26 mo.-----	23.54	64.98	0.394	0.059	1.511
525	III	21-26 mo.-----	28.09	61.61	0.605	0.092	1.611
515	I	48 mo.-----	9.07	88.29	0.134	0.020	0.394
507	II	48 mo.-----	17.55	76.44	0.253	0.042	0.947

TABLE 4.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
507	4.60	0.053	0.024	0.015	0.061	0.023	0.022
505	1.43	0.220	0.046	0.045	0.142	0.036	0.025
503	0.75	0.150	0.014	0.015	0.058	0.022	0.024
504	1.49	0.240	0.030	0.016	0.168	0.093	0.036
523	1.77	0.320	0.032	0.032	0.153	0.038	0.025
525	0.19	0.030	0.011	0.015	0.020	0.009	0.007
515	0.93	0.130	0.028	0.028	0.056	0.023	0.023

TABLE 5.—ANALYSIS OF THE LEAN AND FAT COMPOSITE OF THE USE OF FOOD ANIMALS.
Fresh and Fat-Containing Basis.

Animal	Group	Age	Water	Fat	Ash	Phosphorus	Nitrogen
562 (c)		At birth.....	76.81	4.63	0.983	0.172	2.598
556	I	3 mo.....	71.19	8.51	1.174	0.179	3.049
554	II	3 mo.....	74.02	5.08	1.193	0.191	3.067
555	III	3 mo.....	76.75	3.30	1.051	0.187	3.046
557	I	5 ½ mo.....	58.18	24.98	0.969	0.150	2.509
552	II	5 ½ mo.....	69.80	9.85	1.023	0.169	2.918
548	III	5 ½ mo.....	74.33	4.19	1.049	0.190	3.102
547	I	8 ½ mo.....	62.32	18.82	0.888	0.160	2.718
550	II	8 ½ mo.....	67.56	13.05	0.918	0.180	2.777
558	III	8 ½ mo.....	73.11	6.06	0.945	0.192	3.009
541	I	11 mo.....	60.04	21.27	0.889	0.167	2.902
538	II	11 mo.....	67.94	12.20	0.997	0.180	2.967
540	III	11 mo.....	68.38	11.10	0.980	0.170	2.937
532	I	17-18 mo.....	54.52	27.12	0.843	0.152	2.731
531	III	17-18 mo.....	65.44	11.58	1.077	0.201	3.259
527	I	40 mo.....	36.81	57.91	0.516	0.092	1.630
526	II	40 mo.....	61.65	19.52	0.880	0.150	2.893
524	III	40 mo.....	69.71	7.96	1.014	0.185	3.230
513	I	45 mo.....	38.74	49.93	0.545	0.097	1.675
502	II	45 mo.....	61.96	18.58	0.838	0.159	2.944
509	III	45 mo.....	64.65	15.33	0.880	0.164	3.148

TABLE 5.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
562	5.67	0.77	0.125	0.063	0.493	0.177	0.262
556	5.17	0.69	0.130	0.026	0.655	0.297	0.228
554	4.84	0.85	0.135	0.029	0.617	0.238	0.217
555	4.46	0.91	0.133	0.018	0.580	0.186	0.257
557	3.34	0.62	0.056	0.026	0.448	0.217	0.212
552	4.58	0.75	0.071	0.029	0.626	0.330	0.238
548	4.03	0.81	0.075	0.021	0.542	0.236	0.244
547	4.23	0.69	0.187	0.059	0.450	0.171	0.188
550	4.53	0.75	0.129	0.059	0.505	0.207	0.195
558	4.53	0.81	0.135	0.051	0.469	0.194	0.212
541	4.59	0.73	0.127	0.078	0.511	0.214	0.216
538	4.65	0.83	0.147	0.065	0.555	0.211	0.247
540	4.76	0.83	0.135	0.090	0.547	0.204	0.219
532	4.73	0.74	0.109	0.063	0.523	0.105	0.234
531	5.58	0.96	0.135	0.083	0.666	0.273	0.253
527	-----	-----	0.047	0.014	0.290	0.120	0.104
526	-----	-----	0.102	0.064	0.500	0.227	0.193
524	-----	-----	0.131	0.048	0.590	0.257	0.223
513	1.974	0.563	0.060	0.030	-----	-----	-----
502	4.474	0.675	0.099	0.073	-----	-----	-----
509	4.648	0.679	0.117	0.085	-----	-----	-----

TABLE 6.—COMPOSITION OF THE LOIN LEAN—USE OF FOOD ANIMALS.

Animal	Group	Age	Water	Fat	Ash	Phosphorus	Nitrogen
505	I	11 mo.-----	68.19	9.98	0.963	0.196	3.236
503	II	11 mo.-----	70.99	8.45	0.983	0.190	3.187
504	I	21-26 mo.-----	66.92	12.22	0.946	0.181	3.051
523	II	21-26 mo.-----	69.75	10.41	0.921	0.172	2.027
525	III	21-26 mo.-----	74.63	3.47	1.048	0.200	3.237
515	I	34-35 mo.-----	64.96	15.19	0.994	0.181	2.999
507	II	34-35 mo.-----	70.70	8.10	0.972	0.185	3.128
501	I	48 mo.-----	62.56	17.93	0.851	0.163	2.863
512	II	48 mo.-----	67.61	11.04	0.912	0.170	3.076
500	III	48 mo.-----	70.27	7.73	1.010	0.185	3.113

TABLE 6.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
505	6.17	1.107	0.149	0.080	0.719	0.315	0.312
503	5.51	0.990	0.155	0.153	0.643	0.301	0.236
504	5.16	0.870	0.123	0.073	0.593	0.248	0.246
523	5.62	0.780	0.152	0.099	0.659	0.211	0.233
525	5.71	0.750	0.159	0.128	0.651	0.301	0.267
515	5.18	0.850	0.139	0.103	0.572	0.263	0.216
507	5.96	0.910	0.143	0.122	0.685	0.325	0.248
501	-----	-----	0.117	0.072	0.553	0.273	0.207
512	-----	-----	0.121	0.094	0.653	0.340	0.220
500	-----	-----	0.136	0.102	0.637	0.360	0.270

TABLE 7.—COMPOSITION OF THE ROUND LEAN—USE OF FOOD ANIMALS.
Fresh and Fat-Containing Basis.

Animal	Group	Age	Water	Fat	Ash	Phosphorus	Nitrogen
505	I	11 mo.-----	69.07	9.46	0.976	0.200	3.326
503	II	11 mo.-----	73.09	4.81	1.024	0.204	3.370
504	I	21-26 mo.-----	69.51	9.21	0.983	0.194	3.208
523	II	21-26 mo.-----	76.93	2.31	1.042	0.202	3.155
525	III	21-26 mo.-----	77.03	2.40	1.064	0.205	3.120
515	I	34-35 mo.-----	67.69	11.05	0.924	0.177	3.102
507	II	34-35 mo.-----	72.73	5.77	0.981	0.192	3.230
501	I	48 mo.-----	69.90	9.36	0.957	0.185	3.090
512	II	48 mo.-----	73.27	4.56	1.024	0.192	3.237
500	III	48 mo.-----	74.03	3.49	1.011	0.191	3.123

TABLE 7.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
505	6.15	1.051	0.153	0.097	0.710	0.332	0.330
503	5.98	1.040	0.162	0.164	0.699	0.330	0.225
504	5.98	0.990	0.181	0.093	0.726	0.309	0.296
523	5.59	0.730	0.154	0.125	0.686	0.291	0.237
525	5.79	0.950	0.158	0.120	0.684	0.317	0.252
515	5.48	0.750	0.147	0.115	0.611	0.231	0.213
507	6.00	0.970	0.151	0.113	0.672	0.311	0.180
501	-----	-----	0.133	0.087	0.657	0.320	0.240
512	-----	-----	0.135	0.048	0.677	0.310	0.227
500	-----	-----	0.128	0.109	0.643	0.320	0.270

TABLE 8.—COMPOSITION OF LEAN SAMPLES—MISCELLANEOUS ANIMALS.
Fresh and Fat-Containing Basis.

Animal No.	Age	Treatment or condition	Water	Fat	Ash	Phosphorus	Nitrogen
Lean Composite							
Jersey 43	7 yrs.-----	Fattened on Beef Rations-----	67.09	12.71	0.966	0.186	3.077
Jersey 4	9 yrs.-----	Fattened on Dairy Rations-----	67.37	11.59	1.004	0.191	3.110
Jersey 63	6 yrs.-----	Check-----	68.75	9.49	0.979	0.190	3.200
197	3 yrs., 3 mo.	Thin-----	70.84	9.18	0.937	0.179	3.059
Round and Lean Composite							
18	2½ yrs.-----	Check, thin-----	66.50	13.26	0.883	0.172	3.110
121	2 yrs., 8 mo.	Half fat-----	69.96	8.18	0.957	0.191	3.283
Round Lean							
48	4 yrs., 9 mo.	Very fat overdone-----	64.43	13.42	1.015	0.192	3.278
Loin Lean							
18	2½ yrs.-----	Check thin-----	59.90	21.72	0.788	0.157	2.866
121	2 yrs., 8 mo.	Half fat-----	67.22	11.40	0.943	0.185	3.008
48	4 yrs., 8 mo.	Very fat overdone-----	61.78	18.26	0.956	0.174	2.981
Rib Lean							
18	2½ yrs.-----	Check, thin-----	62.79	18.04	0.821	0.161	3.076
121	2 yrs., 8 mo.	Half fat-----	60.98	20.87	0.777	0.153	2.786
48	4 yrs., 9 mo.	Very fat overdone-----	56.86	24.79	0.827	0.150	2.679
Jerry Rib							
	Lean-----	Fat-----	58.83	23.27	0.828	0.152	2.583
	Fat-----	Fat-----	10.17	87.62	0.128	0.020	0.477

TABLE 8.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
Lean Composite							
43	4.90	0.690	0.135	0.096	0.586	0.237	0.266
4	5.29	0.740	0.188	0.095	0.659	0.249	0.308
63	5.17	0.780	0.145	0.125	0.595	0.271	0.214
197	4.72	0.773	0.132	0.104	0.555	0.197	0.204
Round and Rump Lean Composite							
18	4.98	0.868	0.132	0.092	0.574	0.287	0.210
121	5.74	0.878	0.143	0.035	0.671	0.320	0.258
48	6.00	1.010	0.151	0.125	0.669	0.326	0.216
Loin Lean							
18	4.78	0.781	0.121	0.085	0.550	0.263	0.171
121	5.40	0.872	0.134	0.042	0.647	0.306	0.260
48	5.25	0.790	0.137	0.099	0.616	0.312	0.192
Rib Lean							
18	4.63	0.715	0.112	0.098	0.540	0.271	0.177
121	4.55	0.714	0.114	0.039	0.550	0.251	0.213
48	4.44	0.690	0.122	0.106	0.504	0.214	0.165
Rib Lean and Fat							
Jerry	4.17	0.590	0.188	0.109	0.512	0.197	0.185
	.21	0.030	0.007	0.005	0.013	0.009	0.007

TABLE 9.—COMPOSITION OF THE COMPOSITE FLESH—SPECIAL MAINTENANCE ANIMALS.

Fresh and Fat-Containing Basis.

Animal	Class	Condition	Age	Water	Fat	Ash	Phosphorus	Nitrogen
594	Control-----	Fat-----	11 mos.	62.28	18.50	0.852	0.167	2.922
592	Sub Main- tenance-----	Very, very thin-----	21 mos.	76.37	1.87	1.045	0.174	3.150
591	Sub Main- tenance-----	Very, Thin-----	17 mos.	71.20	6.10	0.888	0.178	3.132
595	Maintenance	Thin-----	23 mos.	70.52	8.47	0.956	0.186	3.082
597	Maintenance	Fairly fat-----	17 mos.	61.89	19.67	0.798	0.151	2.700
593	Super Main- tenance-----	Fat-----	17 mos.	66.62	20.22	0.805	0.160	2.632

TABLE 9.—CONTINUED.

Animal	Soluble Solids	Soluble Ash	Total Soluble Phosphorus	Soluble Organic Phosphorus	Soluble Nitrogen	Albumin & Globulin Nitrogen	Albumose Peptone Nitrogen	Amino Acid & Extractive Nitrogen
594	4.350	0.766	0.127	0.153	0.524	0.239	0.100	0.185
592	4.210	0.890	0.128	0.033	0.463	0.152	0.108	0.203
591	4.850	0.776	0.141	0.085	0.585	0.262	0.112	0.211
595	4.690	0.709	0.143	0.138	0.526	0.240	0.084	0.202
597	4.120	0.647	0.117	0.111	0.497	0.195	0.123	0.179
593	3.730	0.493	0.119	0.107	0.451	0.176	0.106	0.169

TABLE 10.—COMPOSITION OF THE LEAN COMPOSITE—SPECIAL MAINTENANCE ANIMALS.

Fat-Free Basis.

Animal	Age	Condition	Water	Ash	Phosphorus	Nitrogen
594	11 mos.-----	Fat-----	76.58	1.058	0.207	3.523
592	21 mos.-----	Very, very thin-----	77.83	1.065	0.177	3.210
591	17 mos.-----	Very thin-----	76.36	0.954	0.193	3.329
595	23 mos.-----	Thin-----	77.32	1.048	0.206	3.335
597	17 mos.-----	Fairly fat-----	77.95	1.015	0.195	3.299
593	17 mos.-----	Fat-----	76.13	1.044	0.200	3.234

TABLE 10.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
594	5.466	0.966	0.159	0.156	0.665	0.304	0.238
592	4.290	0.907	0.130	0.034	0.472	0.155	0.207
591	5.330	0.864	0.157	0.091	0.649	0.291	0.231
595	5.237	0.810	0.161	0.142	0.588	0.268	0.229
597	5.423	0.842	0.154	0.118	0.647	0.251	0.235
593	4.841	0.661	0.146	0.110	0.582	0.228	0.219

TABLE 11.—COMPOSITION OF THE FAT COMPOSITE—SPECIAL MAINTENANCE ANIMALS.
Fat-Free Basis.

Animal	Age	Condition	Water	Ash	Phosphorus	Nitrogen
594	11 mos.	Fat	73.99	0.852	0.162	4.579
591	21 mos.	Very thin	68.00	0.828	0.138	3.553
595	23 mos.	Thin	71.49	0.956	0.134	4.044
597	17 mos.	Fairly fat	68.56	0.785	0.129	3.962
593	17 mos.	Fat	74.31	0.561	0.197	4.134

TABLE 11.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
594	3.284	0.517	0.107	0.096	0.292	0.122	0.055
591	2.740	0.278	0.042	0.027	0.244	0.104	0.120
595	2.876	0.505	0.070	0.054	0.311	0.132	0.054
597	2.394	0.457	0.062	0.038	0.344	0.159	0.108
593	2.602	0.520	0.197	0.071	0.353	0.126	0.119

TABLE 12.—COMPOSITION OF RIB LEAN—USE OF FOOD ANIMALS.
Fat-Free Basis.

Animal	Group	Age	Water	Ash	Phosphorus	Nitrogen
505	I	11 mo.	76.43	1.041	0.218	3.668
503	II	11 mo.	77.62	1.033	0.206	3.513
504	I	21-26 mo.	76.72	1.088	0.202	3.565
523	II	21-26 mo.	77.49	1.022	0.196	3.439
525	III	21-26 mo.	77.20	1.070	0.198	3.461
515	I	34-35 mo.	76.85	1.066	0.191	3.487
507	II	34-35 mo.	76.85	1.067	0.198	3.417
501	I	48 mo.	75.90	1.019	0.192	3.556
512	II	48 mo.	76.57	1.053	0.185	3.489
500	III	48 mo.	76.57	1.060	0.194	3.645

TABLE 12.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
505	6.113	1.145	0.160	0.135	0.699	0.297	0.332
503	5.492	0.969	0.155	0.155	0.632	0.307	0.252
504	5.613	0.958	0.155	0.107	0.672	0.274	0.276
523	5.050	0.816	0.153	0.079	0.616	0.255	0.257
525	5.160	0.679	0.154	0.134	0.634	0.268	0.231
515	5.830	0.680	0.162	0.112	0.678	0.334	0.242
507	6.140	0.920	0.187	0.126	0.701	0.338	0.212
501	-----	-----	0.125	0.097	0.674	0.335	0.223
512	-----	-----	0.120	0.089	0.678	0.349	0.232
500	-----	-----	0.157	0.124	0.784	0.411	0.282

TABLE 13.—COMPOSITION OF THE RIB FAT—USE OF FOOD ANIMALS.
Fat-Free Basis.

Animal	Age	Age	Water	Ash	Phosphor- us	Nitrogen
505	I	11 mo.-----	74.67	1.143	0.226	4.401
503	II	11 mo.-----	70.45	0.962	0.185	4.480
504	I	21-26 mo.-----	74.44	1.043	0.160	4.300
523	II	21-26 mo.-----	67.22	1.125	0.168	4.315
525	III	21-26 mo.-----	73.17	1.516	0.240	4.196
515	I	34-35 mo.-----	77.46	1.144	0.171	3.365
507	II	34-35 mo.-----	74.49	1.074	0.178	4.020

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
505	4.107	0.363	0.164	0.103	0.418	0.157	0.151
503	4.325	0.665	0.139	0.136	0.430	0.109	0.076
504	3.872	0.774	0.072	0.077	0.299	0.114	0.124
523	4.250	0.685	0.086	0.046	0.480	0.226	0.103
525	4.610	0.834	0.083	0.049	0.399	0.099	0.065
515	1.620	0.260	0.094	0.128	0.171	0.077	0.060
507	3.950	0.550	0.119	0.119	0.338	0.098	0.098

TABLE 14.—COMPOSITION OF THE LEAN AND FAT COMPOSITE—USE OF FOOD
ANIMALS.
Fat-Free Basis.

Animal	Group	Age	Water	Ash	Phospho- rus	Nitrogen
562(c)		At birth.-----	80.54	1.031	0.180	2.724
556	I	3 mo.-----	77.81	1.283	0.196	3.333
554	II	3 mo.-----	77.98	1.257	0.201	3.231
555	III	3 mo.-----	77.37	1.087	0.193	3.150
557	I	5½ mo.-----	77.55	1.292	0.200	3.344
552	II	5½ mo.-----	77.43	1.135	0.187	3.237
548	III	5½ mo.-----	77.58	1.095	0.198	3.238
547	I	8½ mo.-----	76.77	1.094	0.197	3.348
550	II	8½ mo.-----	77.70	1.056	0.207	3.194
558	III	8½ mo.-----	77.83	1.006	0.204	3.203
541	I	11 mo.-----	76.26	1.129	0.212	3.686
538	II	11 mo.-----	77.38	1.136	0.205	3.379
540	III	11 mo.-----	76.92	1.102	0.191	3.304
532	I	17-18 mo.-----	74.81	1.157	0.209	3.747
531	III	17-18 mo.-----	74.01	1.218	0.227	3.686
527	I	40 mo.-----	76.54	1.073	0.191	3.389
526	II	40 mo.-----	76.60	1.093	0.186	3.595
524	III	40 mo.-----	75.74	1.102	0.201	3.509
513	I	45 mo.-----	77.37	1.088	0.194	3.345
502	II	45 mo.-----	77.16	1.029	0.195	3.616
509	III	45 mo.-----	76.36	1.039	0.194	3.718

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
562	5.945	0.807	0.131	0.066	0.517	0.186	0.275
556	5.651	0.754	0.142	0.028	0.716	0.325	0.249
554	5.099	0.895	0.142	0.031	0.650	0.251	0.229
555	4.612	0.941	0.138	0.019	0.600	0.192	0.266
557	4.452	0.826	0.075	0.035	0.597	0.289	0.283
552	5.083	0.832	0.079	0.032	0.694	0.366	0.264
548	4.206	0.845	0.078	0.022	0.566	0.246	0.255
547	5.211	0.850	0.236	0.073	0.530	0.211	0.232
550	5.210	0.863	0.148	0.068	0.581	0.238	0.224
558	4.822	0.862	0.144	0.054	0.499	0.207	0.226
541	5.830	0.930	0.161	0.099	0.649	0.272	0.274
538	5.300	0.950	0.167	0.074	0.632	0.240	0.281
540	5.350	0.930	0.152	0.101	0.615	0.290	0.246
532	6.490	1.015	0.150	0.086	0.718	0.144	0.321
531	6.310	1.090	0.153	0.094	0.753	0.309	0.286
527	-----	-----	0.098	0.029	0.603	0.250	0.216
526	-----	-----	0.127	0.080	0.621	0.282	0.240
524	-----	-----	0.142	0.052	0.641	0.279	0.242
513	3.942	0.725	0.120	0.060	-----	-----	-----
502	5.495	0.829	0.122	0.090	-----	-----	-----
509	5.490	0.820	0.138	0.100	-----	-----	-----

TABLE 15.—COMPOSITION OF LOIN LEAN—USE OF FOOD ANIMALS.
Fat-Free Basis.

Animal	Group	Age	Water	Ash	Phosphorus	Nitrogen
505	I	11 mo.-----	75.75	1.070	0.218	3.595
503	II	11 mo.-----	77.54	1.074	0.208	3.481
504	I	21-26 mo.-----	76.24	1.078	0.206	3.476
523	II	21-26 mo.-----	77.85	1.028	0.192	3.379
525	III	21-26 mo.-----	77.31	1.086	0.207	3.353
515	I	34-35 mo.-----	76.59	1.172	0.213	3.536
507	II	34-35 mo.-----	76.93	1.058	0.201	3.404
501	I	48 mo.-----	76.23	1.037	0.199	3.488
512	II	48 mo.-----	76.00	1.025	0.191	3.458
500	III	48 mo.-----	76.16	1.095	0.200	3.373

TABLE 15.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
505	6.854	1.230	0.166	0.089	0.799	0.350	0.347
503	6.019	0.081	0.169	0.167	0.702	0.329	0.258
504	5.879	0.991	0.140	0.023	0.676	0.283	0.280
523	6.370	0.870	0.170	0.111	0.736	0.236	0.260
525	5.920	0.777	0.165	0.133	0.647	0.312	0.277
515	6.110	1.002	0.164	0.121	0.674	0.310	0.255
507	6.490	0.920	0.156	0.133	0.745	0.354	0.270
501	-----	-----	0.143	0.083	0.674	0.333	0.252
512	-----	-----	0.136	0.106	0.734	0.332	0.247
500	-----	-----	0.147	0.111	0.690	0.390	0.293

TABLE 16.—COMPOSITION OF THE ROUND LEAN—USE OF FOOD ANIMALS.
Fat-Free Basis.

Animal	Group	Age	Water	Ash	Phosphorus	Nitrogen
505	I	11 mo.-----	76.29	1.078	0.221	3.674
503	II	11 mo.-----	76.78	1.076	0.214	3.540
504	I	21-26 mo.-----	76.56	1.083	0.214	3.533
523	II	21-26 mo.-----	78.75	1.067	0.207	3.230
525	III	21-26 mo.-----	78.92	1.090	0.210	3.197
515	I	34-35 mo.-----	76.10	1.039	0.199	3.487
507	II	34-35 mo.-----	77.18	1.041	0.204	3.428
501	I	48 mo.-----	77.12	1.056	0.204	3.409
512	II	48 mo.-----	76.77	1.073	0.201	3.392
500	III	48 mo.-----	76.71	1.048	0.198	3.236

TABLE 16.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
505	6.793	1.161	0.169	0.107	0.784	0.367	0.364
503	6.282	1.093	0.170	0.172	0.734	0.347	0.268
504	6.587	1.090	0.199	0.102	0.800	0.340	0.326
523	5.720	0.750	0.158	0.128	0.702	0.298	0.243
525	5.930	0.973	0.162	0.123	0.701	0.325	0.258
515	6.160	0.843	0.165	0.129	0.687	0.260	0.239
507	6.370	1.030	0.160	0.120	0.713	0.330	0.191
501	-----	-----	0.147	0.096	0.725	0.353	0.265
512	-----	-----	0.141	0.050	0.709	0.325	0.238
500	-----	-----	0.133	0.113	0.666	0.332	0.280

TABLE 17.—COMPOSITION OF THE LEAN SAMPLES—MISCELLANEOUS ANIMALS.
Fat-Free Basis.

Animal	Treatment Condition	Age	Water	Ash	Phosphorus	Nitrogen
Lean Composite						
Jersey 63	Check.....	6 yrs.....	75.96	1.082	0.210	3.536
Jersey 4	Fattened on Dairy Ration.....	9 yrs.....	76.20	1.136	0.216	3.518
Jersey 43	Fattened on Beef Ration.....	7 yrs.....	76.86	1.107	0.213	3.525
197	Thin.....	3 yrs. 3 mo.	78.00	1.032	0.197	3.368
Round and Rump Lean						
18	Check, thin.....	2½ yrs.....	76.67	1.018	0.198	3.585
121	Half fat.....	2 yrs. 8 mo.	76.19	1.042	0.208	3.575
Round Lean						
48	Very fat, overdone.....	4 yrs. 9 mo.	74.42	1.172	0.222	3.786
Loin Lean						
18	Check, thin.....	2½ yrs.....	76.52	1.006	0.201	3.661
121	Half fat.....	2 yrs. 8 mo.	75.87	1.064	0.209	3.395
48	Very fat, overdone.....	4 yrs. 9 mo.	75.58	1.170	0.213	3.647
Rib Lean						
18	Check, thin.....	2½ yrs.....	76.61	1.002	0.196	3.753
121	Half fat.....	2 yrs. 8 mo.	77.06	0.982	0.193	3.521
48	Very fat, overdone.....	4 yrs. 9 mo.	75.60	1.100	0.199	3.562
	Lean.....		76.67	1.070	0.198	3.366
Jerry Rib						
	Fat.....		82.15	1.034	0.162	3.853

TABLE 17.—CONTINUED.

Animal	Soluble solids	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Coagulable nitrogen	Amino acid and extractive nitrogen
Lean Composite							
Jersey 63	5.712	0.862	0.160	0.138	0.657	0.299	0.236
Jersey 4	5.983	0.837	0.213	0.107	0.745	0.282	0.348
Jersey 43	5.613	0.790	0.155	0.110	0.671	0.272	0.305
197	5.197	0.851	0.145	0.115	0.611	0.217	0.225
Round and Rump Lean							
18	5.471	1.001	0.152	0.106	0.106	0.331	0.242
121	6.251	0.956	0.156	0.038	0.731	0.349	0.281
Round Lean							
48	6.930	1.167	0.174	0.144	0.773	0.377	0.249
Loin Lean							
18	6.106	0.998	0.155	0.109	0.703	0.336	0.218
121	6.095	0.984	0.151	0.047	0.730	0.345	0.293
48	6.423	0.966	0.168	0.121	0.754	0.382	0.235
Rib Lean							
18	5.649	0.872	0.137	0.120	0.659	0.331	0.216
121	5.750	0.902	0.144	0.049	0.695	0.317	0.269
48	5.903	0.917	0.162	0.141	0.670	0.285	0.219
Jerry							
	5.435	0.769	0.154	0.142	0.667	0.257	0.241
	1.696	0.242	0.057	0.040	0.105	0.073	0.057

TABLE 18.—COMPOSITION OF THE COMPOSITE FLESH—SPECIAL MAINTENANCE ANIMALS.
Fat-Free Basis.

Animal	Class	Condition	Age	Water	Ash	Phosphorus	Nitrogen	Soluble Solids
594	Control.....	Fat.....	11 mos.	76.42	1.045	.205	3.585	5.33
592	Sub Maintenance --	Very, very thin.....	21 mos.	77.04	1.054	.176	3.180	4.29
591	Sub Maintenance --	Very, thin.....	17 mos.	75.83	.946	.190	3.343	5.16
595	Maintenance.....	Thin.....	23 mos.	77.04	1.044	.203	3.367	5.12
597	Maintenance.....	Fairly, fat.....	17 mos.	77.05	.993	.188	3.361	5.13
593	Super Maintenance.	Fat.....	17 mos.	75.99	1.009	.201	3.299	4.68

TABLE 18.—CONTINUED.

Animal	Soluble ash	Total soluble phosphorus	Soluble organic phosphorus	Soluble nitrogen	Albumin and globulin-nitrogen	Albumose peptone nitrogen	Amino acid and extractive nitrogen
594	0.940	0.156	0.124	0.643	0.293	0.123	0.227
592	0.907	0.130	0.033	0.467	0.153	0.109	0.205
591	0.826	0.150	0.080	0.623	0.279	0.133	0.225
595	0.775	0.156	0.126	0.575	0.262	0.092	0.221
597	0.805	0.146	0.089	0.619	0.243	0.153	0.223
593	0.618	0.149	0.085	0.565	0.221	0.132	0.212

TABLE 19.—PERCENTAGE COMPOSITION OF ADDITIONAL SAMPLES—FRESH BASIS.

Animal	Group	Age	Water	Fat	Ash	Phos- phorus	Nitrogen	Soluble solids	Soluble ash	Total phos- phorus	Soluble organic phos- phorus	Soluble nitrogen	Coagu- lable nitrogen	Amino acid ex- tractive nitrogen
"Look- me-over"							Rib Lean							
			55.78	27.14	0.771	0.145	2.626	3.81	0.60	0.279	0.170	0.455	0.189	0.198
48	Very fat----	57 mo.	36.91	52.67	0.509	0.093	1.587	2.27	0.44	0.058	0.051	0.228	0.087	0.091
504	I	21-26 mo.	40.72	46.81	0.574	0.106	1.847	2.55	0.44	0.077	0.031	0.285	0.086	0.132
501	I	48 mo.	28.77	62.76	0.395	0.069	1.140	---	---	0.034	0.024	0.120	0.050	0.050
512	II	48 mo.	44.60	41.83	0.667	0.119	2.027	---	---	0.069	0.056	0.333	0.160	0.143
500	III	48 mo.	55.15	27.64	0.819	0.145	2.527	---	---	0.095	0.069	0.498	0.250	0.157
							Lean and Fat Composite							
501	I	48 mo.	37.16	51.45	0.574	0.089	1.617	---	---	---	---	0.255	0.118	0.116
512	II	48 mo.	55.38	27.26	0.781	0.137	2.843	---	---	---	---	0.449	0.202	0.157
500	III	48 mo.	63.37	17.39	0.923	0.162	2.900	---	---	---	---	0.537	0.268	0.199
							Lean and Fat Composite (Partial)							
501	I	48 mo.	31.24	60.09	0.404	0.071	1.377	---	---	0.042	0.023	0.160	0.073	0.060
512	II	48 mo.	48.57	35.61	0.686	0.111	2.393	---	---	0.075	0.043	0.327	0.133	0.120
500	III	48 mo.	60.31	20.18	0.905	0.153	2.923	---	---	0.107	0.062	0.473	0.227	0.173
							Flank and Plate, Lean and Fat Composite							
18	Thin----	30 mo.	52.51	30.10	0.645	0.124	2.440	---	0.618	0.087	0.087*	0.366	0.167	0.114
121	Half fat----	32 mo.	40.07	47.70	0.500	0.095	1.924	2.57	0.530	0.072	0.011*	0.278	0.116	0.123
48	Very fat----	57 mo.	30.15	61.11	0.421	0.064	1.308	1.38	0.200	0.038	0.036	0.151	0.047	0.050
505	I	11 mo.	43.72	42.76	0.580	0.116	2.211	2.73	0.288	0.064	0.068	0.305	0.112	0.139
503	II	11 mo.	56.52	25.67	0.748	0.136	2.742	3.62	0.720	0.105	0.099	0.402	0.168	0.162
504	I	21-26 mo.	41.64	45.62	0.572	0.101	1.945	2.27	0.460	0.020	0.029	0.281	0.079	0.130
							Shin and Shank, Head and Tail, Lean and Fat Composite							
18	Thin----	30 mo.	67.43	11.99	0.771	0.112	2.539	3.26	0.717	0.088	0.105*	0.455	0.208	0.165
121	Half fat----	32 mo.	62.40	18.18	0.771	0.112	2.539	3.26	0.717	0.100	0.016*	0.430	0.187	0.173
48	Very fat----	57 mo.	57.87	23.47	0.829	0.132	2.853	3.91	0.970	0.122	0.019	0.427	0.146	0.200
505	I	11 mo.	64.33	15.40	0.818	0.126	2.816	4.00	0.775	0.107	0.037	0.475	0.206	0.175
503	II	11 mo.	68.71	10.22	0.847	0.168	3.196	4.08	0.720	0.120	0.116	0.452	0.172	0.166
504	I	21-26 mo.	60.64	20.56	0.803	0.146	2.951	3.44	0.550	0.098	0.089	0.413	0.149	0.168

TABLE 19.—CONTINUED.

Animal	Group	Age	Water	Fat	Ash	Phos- phorus	Nitrogen	Soluble solids	Soluble ash	Total phos- phorus	Soluble organic phos- phorus	Soluble nitrogen	Coagu- lable nitrogen	Amino acid ex- tractive nitrogen
Chuck and Neck, Lean and Fat Composite														
18	Thin	30 mo.	66.48	14.07	0.818	0.154	3.019	4.73	0.834	0.120	0.107*	0.520	0.253	0.188
121	Half fat	32 mo.	59.14	24.43	0.702	0.142	2.605	3.87	0.617	0.100	0.015*	0.418	0.160	0.179
48	Very fat	57 mo.	40.67	34.92	0.693	0.123	2.267	3.06	0.540	0.087	0.065	0.345	0.160	0.129
541	I	11 mo.	65.26	14.72	0.913	0.125	2.942	4.50	0.710	0.134	0.098	0.548	0.200	0.332
538	I	11 mo.	68.49	11.56	0.931	0.174	2.971	4.23	0.830	0.132	0.099	0.521	0.193	0.318
540	II	11 mo.	68.49	11.56	0.931	0.174	2.971	4.23	0.830	0.132	0.099	0.521	0.193	0.318
505	I	11 mo.	62.29	18.95	0.886	0.178	2.961	4.46	0.700	0.115	0.104	0.517	0.168	0.226
504	I	11 mo.	68.53	12.57	0.850	0.165	2.886	4.61	0.951	0.115	0.092	0.502	0.195	0.187
503	I	21-26 mo.	68.53	12.57	0.850	0.165	2.886	4.61	0.951	0.115	0.092	0.502	0.195	0.187
523	I	21-26 mo.	70.88	24.03	0.758	0.146	2.620	3.69	0.620	0.100	0.083	0.445	0.151	0.131
525	I	21-26 mo.	70.88	24.03	0.758	0.146	2.620	3.69	0.620	0.100	0.083	0.445	0.151	0.131
515	I	34-35 mo.	53.27	31.09	0.921	0.171	2.986	4.83	0.850	0.129	0.093	0.558	0.221	0.182
507	I	34-35 mo.	65.57	15.17	0.862	0.157	2.891	3.41	0.540	0.091	0.074	0.377	0.128	0.147
501	I	48 mo.	47.70	38.43	0.652	0.118	1.525	4.68	0.720	0.080	0.052	0.330	0.130	0.137
512	I	48 mo.	63.19	18.19	0.919	0.150	2.826	---	---	0.079	0.079	0.497	0.200	0.177
500	III	48 mo.	67.59	11.87	0.912	0.158	3.387	---	---	0.112	0.092	0.589	0.263	0.207
Head and Tail, Shin and Shank, Flank and Plate, Lean and Fat Composite														
524	II	21-26 mo.	59.91	21.71	0.899	0.154	2.796	3.22	0.440	0.105	0.076	0.448	0.168	0.128
525	III	21-26 mo.	65.46	16.88	0.865	0.154	2.807	3.71	0.630	0.112	0.084	0.438	0.195	0.167
513	I	34-35 mo.	36.59	53.17	0.417	0.078	1.509	1.68	0.350	0.045	0.023	0.189	0.074	0.078
507	II	34-35 mo.	55.77	26.66	0.751	0.137	2.557	3.57	0.673	0.117	0.107	0.409	0.171	0.140
Round Fat														
121*	Half fat	32 mo.	14.41	80.61	0.153	0.030	0.177	0.63	0.052	0.020	0.004*	0.038	0.024	0.012
48	Very fat	57 mo.	27.75	67.35	0.351	0.027	0.765	0.52	0.090	0.010	0.010	0.034	0.028	0.047
503*	I	11 mo.	14.14	80.64	0.174	0.032	0.452	0.64	0.143	0.016	0.009	0.055	0.020	0.020
504*	I	21-26 mo.	22.45	70.13	0.287	0.045	1.212	1.04	0.180	0.033	0.035	0.099	0.031	0.008
504	I	21-26 mo.	16.61	78.05	0.238	0.030	0.906	0.57	0.100	0.011	0.011	0.041	0.009	0.019
523	I	21-26 mo.	29.54	60.22	0.357	0.048	1.580	1.03	0.050	0.027	0.012	0.101	0.054	0.059
525	I	21-26 mo.	32.69	56.83	0.433	0.056	1.599	1.29	0.230	0.029	0.016	0.155	0.010	0.023
515	I	34-35 mo.	77.70	17.52	0.215	0.026	0.784	0.34	0.070	0.019	0.017	0.025	0.012	0.017
507	II	34-35 mo.	24.45	68.67	0.276	0.039	1.093	0.57	0.130	0.018	0.014	0.050	0.026	0.040
Rib Fat														
121	Half fat	32 mo.	86.04	0.135	0.027	0.027	0.453	0.48	0.068	0.012	0.002*	0.022	0.022	0.004
48	Very fat	57 mo.	15.81	81.37	0.155	0.021	0.431	0.38	0.070	0.005	0.006	0.020	0.022	0.003
Fat Composite, Round Loin, Rib														
501	I	48 mo.	10.31	87.63	0.120	0.018	0.324	0.65	0.150	0.012	0.010	0.047	0.026	0.013
512	II	48 mo.	10.18	86.89	0.138	0.019	0.423	---	---	0.007	0.004	0.010	0.010	0.067
500	III	48 mo.	20.35	79.15	0.245	0.031	0.783	---	---	0.012	0.005	0.030	0.002	0.010
			70.85	70.85	0.308	0.043	1.255	---	---	0.019	0.011	0.054	0.020	0.025

*Inorganic phosphorus.

TABLE 20.—PERCENTAGE COMPOSITION OF ADDITIONAL SAMPLES—FRESH BASIS.

Animal	Group	Age	Water	Fat	Ash	Phos- phorus	Nitrogen	Soluble solids	Soluble ash	Total phos- phorus	Soluble organic phos- phorus	Soluble nitrogen	Coagu- lable nitrogen	Amino acid ex- tractive nitrogen
121	Half fat----	32 mo.	9.08	87.84	0.133	0.024	Loin Fat 0.396	0.46	0.083	0.014	0.006*	0.018	0.011	0.001
48	Very fat --	57 mo.	12.60	84.76	0.146	0.023	0.426	0.43	0.170	0.005	0.007	0.012	0.022	0.015
505	I	11 mo.	9.33	87.55	0.127	0.024	0.535	0.49	0.045	0.017	0.006	0.052	0.025	0.013
503	II	11 mo.	15.75	79.02	0.190	0.035	0.777	0.87	0.180	0.027	0.019	0.076	0.035	0.015
504	I	21-26 mo.	11.62	84.91	0.162	0.025	0.532	0.43	0.060	0.015	0.014	0.040	0.007	0.016
523	II	21-26 mo.	16.50	77.93	0.281	0.045	0.863	0.82	0.030	0.016	0.011	0.098	0.068	0.021
525	III	21-26 mo.	22.00	69.59	0.294	0.040	1.099	1.12	0.180	0.019	0.012	0.099	0.019	0.019
515	I	34-35 mo.	10.58	86.62	0.115	0.017	0.412	0.25	0.030	0.009	0.010	0.019	0.011	0.015
507	II	34-35 mo.	17.82	76.68	0.223	0.039	0.826	0.55	0.120	0.022	0.015	0.052	0.025	0.030
63		6 yrs.	19.40	72.17	0.293	Fat Composite 0.044	1.225	0.56	0.120	0.015	0.010	0.051	0.118	0.015
4		9 yrs.	13.37	82.51	0.208	0.031	0.626	0.63	0.080	0.104	0.007	0.047	0.035	0.019
43		7 yrs.	16.73	77.76	0.247	0.033	1.145	0.78	0.070	0.019	0.010	0.069	0.036	0.028
197	Thin-----	38 mo.	22.83	70.13	0.265	0.034	1.087	0.57	0.180	0.017	0.011	0.048	0.027	0.011
121	Half fat----	32 mo.	68.36	4.72	1.312	0.353	Liver 3.191	8.05	0.942	0.177	0.022*	0.529	0.231	0.188

TABLE 21.—PERCENTAGE COMPOSITION OF ADDITIONAL SAMPLES—FAT-FREE BASIS.

Animal	Group	Age	Water	Ash	Phos- phorus	Nitrogen	Soluble solids	Soluble ash	Total soluble phos- phorus	Soluble organic phos- phorus	Soluble nitrogen	Coagu- lable nitrogen	Amino acid ex- tractable nitrogen
"Look- me-over"						Rib Lean							
48	Very fat.	57 mo.	76.56	1.058	0.199	3.604	5.229	0.823	0.383	0.233	0.624	0.259	0.272
504	I	21 mo.	77.98	1.079	0.196	3.353	4.796	0.930	0.123	0.108	0.482	0.184	0.192
501	I	48 mo.	76.56	1.079	0.192	3.472	4.794	0.827	0.143	0.038	0.536	0.162	0.248
512	II	48 mo.	77.26	1.061	0.183	3.061	—	—	0.091	0.064	0.522	0.194	0.134
500	III	48 mo.	76.67	1.147	0.205	3.485	—	—	0.119	0.096	0.572	0.275	0.246
		48 mo.	76.22	1.132	0.200	3.492	—	—	0.131	0.095	0.688	0.345	0.217
						Lean and Fat Composite							
501	I	48 mo.	76.54	1.182	0.183	3.330	—	—	—	—	0.525	0.243	0.239
512	II	48 mo.	76.13	1.074	0.188	3.496	—	—	—	—	0.617	0.278	0.216
500	III	48 mo.	76.71	1.117	0.196	3.510	—	—	—	—	0.662	0.324	0.241
						Lean and Fat Composite (Partial)							
501	I	48 mo.	78.28	1.012	0.178	3.450	—	—	0.105	0.508	0.401	0.183	0.150
512	II	48 mo.	75.43	1.065	0.172	3.716	—	—	0.116	0.067	0.508	0.207	0.186
500	III	48 mo.	75.56	1.133	0.192	3.662	—	—	0.134	0.078	0.593	0.284	0.217
						Flank and Plate, Lean and Fat Composite							
18	Thin.	30 mo.	75.12	0.928	0.177	3.491	4.993	0.884	0.124	0.124	0.524	0.239	0.163
121	Half fat.	32 mo.	76.62	0.956	0.182	3.679	4.914	1.013	0.138	0.091	0.532	0.222	0.235
48	Very fat.	57 mo.	77.53	1.083	0.165	3.363	3.548	0.746	0.098	0.093	0.337	0.121	0.129
505	I	11 mo.	76.38	1.013	0.203	3.863	4.752	1.027	0.112	0.014	0.533	0.196	0.243
503	II	11 mo.	76.08	1.096	0.183	3.689	4.870	0.969	0.141	0.133	0.541	0.226	0.218
504	I	21-26 mo.	76.57	1.052	0.186	3.577	4.174	0.846	0.037	0.053	0.517	0.145	0.239
						Shin and Shank, Head and Tail, Lean and Fat Composite							
18	Thin.	30 mo.	76.62	0.876	0.165	3.658	4.840	0.815	0.100	0.119†	0.517	0.236	0.187
121	Half fat.	32 mo.	76.14	0.896	0.174	3.580	4.620	0.827	0.122	0.020	0.526	0.229	0.211
48	Very fat.	57 mo.	75.62	1.083	0.186	3.728	5.109	1.032	0.139	0.035	0.558	0.191	0.261
505	I	11 mo.	76.16	0.967	0.195	3.801	4.728	0.916	0.126	0.044	0.561	0.243	0.207
503	II	11 mo.	77.65	0.943	0.187	3.560	4.544	0.802	0.134	0.129	0.503	0.191	0.185
504	I	21-26 mo.	76.33	1.011	0.184	3.715	4.340	0.692	0.123	0.112	0.520	0.188	0.211

TABLE 21.—CONTINUED.

Animal	Group	Age	Water	Ash	Phos- phorus	Nitrogen	Soluble salts	Soluble ash	Total phos- phorus	Soluble organic phos- phorus	Soluble nitrogen	Coagu- lable nitrogen	Amino acid ex- tractive nitrogen
Chuck and Neck, Lean and Fat Composite													
18	Thin	30 mo.	77.37	0.952	0.179	3.513	5.504	0.971	0.140	0.125†	0.605	0.294	0.219
121	Half fat	32 mo.	78.26	0.929	0.188	3.447	5.121	0.816	0.132	0.020†	0.553	0.212	0.237
48	Very fat	57 mo.	76.36	1.065	0.189	3.485	4.704	0.830	0.134	0.100	0.530	0.246	0.198
541	I	11 mo.	76.57	1.071	0.194	3.452	5.280	0.830	0.145	0.115	0.643	0.235	0.272
538	II	11 mo.	77.59	1.057	0.198	3.375	4.800	0.940	0.139	0.112	0.592	0.219	0.248
540	III	11 mo.	77.79	1.076	0.194	3.231	4.870	0.760	0.151	0.113	0.575	0.183	0.247
505	I	11 mo.	76.85	1.024	0.204	3.561	5.688	1.173	0.142	0.114	0.638	0.268	0.280
503	II	11 mo.	78.38	0.995	0.196	3.379	5.113	0.892	0.145	0.143	0.574	0.223	0.214
504	I	21 mo.	76.78	0.998	0.192	3.449	4.857	0.816	0.132	0.109	0.586	0.199	0.172
523	II	21-26 mo.	79.01	1.027	0.191	3.329	5.380	0.950	0.144	0.096	0.547	0.245	0.203
525	III	21-26 mo.	77.71	1.036	0.194	3.413	5.210	0.852	0.135	0.102	0.609	0.241	0.248
515	I	34-35 mo.	77.30	1.033	0.183	3.419	4.950	0.784	0.142	0.107	0.547	0.186	0.213
507	II	34-35 mo.	77.30	1.016	0.185	3.408	5.520	0.850	0.146	0.134	0.587	0.223	0.224
501	I	48 mo.	77.47	1.059	0.192	2.477	-----	-----	0.130	0.084	0.536	0.211	0.223
512	II	48 mo.	77.24	1.133	0.183	3.454	-----	-----	0.130	0.097	0.536	0.244	0.216
500	III	48 mo.	76.69	1.035	0.179	3.843	-----	-----	0.134	0.104	0.668	0.298	0.235
Head and Tail, Shin and Shank, Flank, Plate and Rump, Lean and Fat Composite													
523	II	21-26 mo.	76.52	1.148	0.197	3.571	4.11	0.562	0.134	0.097	0.572	0.215	0.163
525	III	21-26 mo.	78.75	1.041	0.185	3.377	4.46	0.758	0.135	0.101	0.527	0.235	0.201
515	I	34-35 mo.	78.13	0.890	0.167	3.222	3.59	0.750	0.096	0.049	0.404	0.158	0.167
507	II	34-35 mo.	76.04	1.024	0.187	3.487	4.87	0.920	0.160	0.146	0.558	0.223	0.191
Round Fat													
121*	Half Fat	32 mo.	74.32	0.789	0.155	0.603	3.249	0.268	0.103	0.021	0.196	0.124	0.062
48	Very Fat	37 mo.	94.99	0.769	0.083	2.343	1.583	0.378	0.103	0.031	0.104	0.086	0.144
503*	I	11 mo.	73.04	0.899	0.165	2.335	3.306	0.739	0.083	0.046	0.284	0.103	0.103
504	II	21-26 mo.	75.16	0.961	0.167	4.058	3.482	0.603	0.111	0.117	0.331	0.104	0.027
523	II	21-26 mo.	75.60	1.083	0.137	4.024	2.594	0.455	0.051	0.050	0.187	0.041	0.086
525	III	21-26 mo.	74.26	0.897	0.121	3.972	2.590	0.455	0.069	0.030	0.254	0.136	0.073
515	I	21-26 mo.	75.72	1.003	0.150	3.704	2.590	0.353	0.085	0.037	0.359	0.023	0.053
507	II	34-35 mo.	78.57	0.964	0.117	3.816	1.520	0.314	0.085	0.036	0.112	0.054	0.076
			78.04	0.881	0.124	3.489	1.820	0.410	0.057	0.045	0.160	0.083	0.128
Rib Fat													
121	Half Fat	32 mo.	76.50	0.967	0.193	3.245	3.438	0.487	0.086	0.014	0.158	0.158	0.021
48	Very Fat	57 mo.	84.86	0.832	0.113	2.513	2.040	0.376	0.027	0.032	0.107	0.118	0.021
Fat Composite, Round, Lean and Rib													
501	I	48 mo.	77.65	1.053	0.145	3.227	5.255	1.213	0.097	0.081	0.380	0.210	0.105
512	II	48 mo.	74.34	1.175	0.149	3.755	-----	-----	0.053	0.031	0.076	0.076	0.511
500	III	48 mo.	69.81	1.051	0.148	4.305	-----	-----	0.058	0.034	0.144	0.010	0.048
									0.065	0.038	0.185	0.069	0.086

†Inorganic phosphorus.

*Round and rump fat.

TABLE 22. PERCENTAGE COMPOSITION OF ADDITIONAL SAMPLES—FAT-FREE BASIS.

Animal	Group	Age	% water	Ash	Phos- phorus	Nitrogen		Soluble solids	Soluble ash	Total soluble phos- phorus	Soluble organic phos- phorus	soluble nitrogen	Casein nitrogen	Amo- acid ex- tractable nitrogen
						Lean	Fat							
121	Head fat	22 mos.	74.67	1.094	0.197	3.257	3.783	0.683	0.115	0.049	0.148	0.060	0.060	
42	Veal fat	57 mos.	82.62	0.752	0.151	2.795	2.821	1.115	0.033	0.036	0.079	0.144	0.068	
503	"	11 mos.	74.94	1.020	0.193	4.207	3.936	0.361	0.137	0.048	0.412	0.201	0.164	
503	"	11 mos.	72.43	0.946	0.174	3.870	4.343	0.296	0.134	0.075	0.372	0.174	0.075	
598	"	21 mos.	77.06	1.074	0.166	3.546	2.850	0.398	0.099	0.053	0.265	0.046	0.106	
575	"	21 mos.	74.76	1.273	0.204	3.016	3.720	0.116	0.079	0.050	0.444	0.092	0.095	
575	"	21 mos.	72.34	0.967	0.132	3.613	3.680	0.524	0.042	0.039	0.376	0.063	0.062	
515	"	34 mos.	75.07	0.859	0.177	3.079	1.870	0.220	0.067	0.075	0.142	0.063	0.112	
597	"	34 mos.	76.42	0.956	0.167	3.732	2.360	0.510	0.074	0.064	0.223	0.107	0.129	
63	Casein	6 yrs.	69.71	1.053	0.152	4.402	2.102	0.411	0.054	0.036	0.018	0.065	0.377	
4	"	9 yrs.	76.44	1.129	0.177	3.279	3.602	0.457	0.595	0.040	0.269	0.209	0.109	
43	Fat	7 yrs.	75.77	1.111	0.148	3.142	3.507	0.315	0.083	0.045	0.310	0.162	0.126	
197	Lean	32 mos.	76.43	0.887	0.114	3.659	1.908	0.603	0.057	0.037	0.161	0.090	0.037	
121	Head fat	32 mos.	71.75	1.377	0.370	5.349	8.449	0.589	0.186	0.023	0.555	0.242	0.197	

BIOGRAPHICAL NOTE

Walter S. Ritchie attended Ohio State University 1911-1916, graduating in 1916 with the degree of Bachelor of Science in Agriculture. He has been connected with the Department of Agricultural Chemistry of the University since January 1917. During that time he did graduate work in Agricultural Chemistry, Organic Chemistry, Physiological Chemistry, receiving the degree of Master of Arts in 1918. Since September 1920, he has been Assistant Professor of Agricultural Chemistry at the University of Missouri.

